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Topics of the Month

Chemical engineering research

FOR once it is possible to apply those often misused adjectives, 'admirable,' 'unique' and 'much-needed,' to a report which really deserves them. This is the report of the Committee on Chemical Engineering Research, which was set up by the Advisory Council of the D.S.I.R. more than two years ago to report on the needs for research in chemical engineering in Great Britain. As will be seen from the extracts we publish in this issue, much shrewdly planned investigation and a lot of hard thinking have been lavished on this document. It confirms much that was suspected about the condition of chemical engineering in Great Britain and discloses much that is new. It is not a comforting report, but it is a hopeful one. There is a lot of research going on, but it is not co-ordinated and, therefore, it is uneven. Add to this the fact that research facilities are quite inadequate, and it is not surprising that the list of research requirements covers every subject in chemical engineering.

The reason for the neglect of chemical engineering research is not hard to find. It is only within the past 20 to 30 years that it has been realised in the U.K. that there is such a subject as *chemical* engineering, a study distinct from chemistry and other forms of engineering. The committee are right, therefore, to emphasise at the beginning of their report that chemical engineering is not restricted to those industries using chemical reactions but extends into almost every industry. Indeed, 'most industries, in a sense, are chemical industries and chemical engineering is not less important than mechanical and electrical engineering in servicing them.' Until the importance of chemical engineering is fully appreciated by the Government and industry we shall continue to have only two university departments (London and Birmingham) with really significant chemical engineering schools, and industry will continue to be niggardly in spending money on chemical engineering research.

A new research organisation

SO much for the depressing side of the report. It gives hope because it provides, for the first time, a clear statement of the information practising chemical engineers want, the research projects which should be undertaken, the facilities which now exist and the facilities which should be provided. It should help enormously in preventing duplicated and badly planned research. Furthermore, a national policy for chemical engineering research is outlined. The basis of this is the creation of a central *chemical engineering* research organisation. The committee admit that some of the newer research associations intend to develop chemical

engineering departments, but they argue that this development has limited use because such research will be specific, whereas the need is for general study of plant and operations which are generally and widely applicable to all industries. Another reason why the allocation of problems among existing research organisations would not be satisfactory is that the normal sectional interests of these bodies would not permit the high priority which is deemed necessary for the problems in mind. Broadly, the committee find that these research needs are of two kinds: the one relating to experimental investigations designed to eludicate the mechanism of the basic operations employed in industry (*e.g.* drying, filtering and evaporating), and the other to the provision of practical quantitative data, based upon large-scale operations, which are required for design purposes.

Although their terms of reference did not require them to do so they have made recommendations (not published) to the D.S.I.R. on means of filling in the gaps in the supply of essential chemical engineering research data. Throughout the report the committee convincingly emphasise the urgency of improving research facilities. As they rightly observe, striking examples can be given of manufacturing operations originating in this country being left to other countries to develop or modernise. The result is that they are sometimes used here under foreign licences or operated in plant purchased from abroad or constructed to foreign designs. Frequent comments were made to the committee on the delay in using new discoveries by our own scientists. The tempo of exploitation of scientific research has increased so much now that, unless design specifications and estimates for process equipment can be submitted quickly and accurately, orders for it are lost to other countries. There is no time to wait.

Australia's titanium discovery

DURING a search by scientists of the Australian Bureau of Mineral Resources for the radioactive mineral, monazite, along the northern New South Wales and southern Queensland beaches, what are described as the world's biggest deposits of titanium-bearing minerals have been found. These minerals are zircon, rutile and ilmenite and they lie on the beaches and sand dunes about 50 miles north and south of the N.S.W.-Queensland borders. By any standards this is an important discovery. However, it gains in importance by the fact that titanium is now being developed as a major metal of industry. In the U.S., in Canada and in the U.K., work is proceeding on devising better processes for extracting light, ductile and corrosion-resistant titanium from its ores. In Australia itself the Commonwealth Scientific and Industrial Research Organisation are undertaking pure research on this new metal (see INTERNATIONAL CHEMICAL ENGINEERING, November 1951, p. 541). However, the key to the development of titanium on a scale comparable with, say, aluminium, is undoubtedly an improved extraction process (see p. 44).

To return to the Australian titanium 'bonanza,' the Zinc Corpn. already has a trial extraction plant operating on Stradbroke Island, Queensland, and soon expects to begin large-scale production. Meanwhile, Australia will continue to export rutile, the chief source of titanium, in, presumably, increasing quantities. Last year, for instance, the U.K. took about one-third of the 15,000 tons of rutile exported by Australia. This was used mainly for the manufacture of titanium dioxide, the paint pigment, the biggest single use, so far, of titanium.

Atomic energy for industry

ASKED in Parliament what progress had been made in British national research stations with the problem of harnessing atomic energy for industrial, travel and other peaceful development purposes, and when it was likely to be available for use for such purposes, the Minister of Supply, said that progress had been made in the detailed study of individual technological problems which must be solved before the construction of an experimental power reactor could be undertaken. The development of the supply of nuclear fuel and of the chemical separation processes connected with its production was proceeding satisfactorily. Facilities had been or were being established for the production of the rare metals which would probably be required. The first stages in the work on design studies of experimental reactors for marine propulsion were being concluded and further work would be undertaken. Studies were being made of other types of reactor.

There was a steadily increasing demand, both at home and abroad, for radioactive isotopes for use in industry, medicine and science, and improved facilities for production and distribution, and for training in their use, were being made available. More than 800 consignments were now being delivered each month.

However, the Minister concluded, the use of atomic energy for industrial power, or as a means of locomotion, was still in a very early stage.

Length, mass and time

THE first of a short series of pamphlets under preparation by the National Physical Laboratory describing the standards of measurement employed has appeared. It deals with the fundamental units of length, mass and time and also defines the derivatives from these fundamentals, namely the units of volume, density and specific gravity, and deals with the acceleration due to gravity, as well as with force and pressure, with particular reference to barometric pressure. Both the British Imperial system and the International Metric system are dealt with in the pamphlet.

The standards in the British system are, of course, the basis for the whole of our weights and measures and as such they are of cardinal importance to all branches of science and industry.

In one section of the pamphlet it is recorded that the Imperial Standard Yard is in the custody of the Board of Trade. This standard is a bar of bronze 1 in. square in section and 38 in. long. At 1 in. from each end is a hole $\frac{1}{2}$ in. in diameter and $\frac{1}{2}$ in. deep. At the centre of and flush with the bottom of each hole is inserted a polished gold plug on which three lines are drawn at right-angles to the length of the bar. The length of the yard is defined as the distance between the central lines on these plugs when the bar is at a temperature of 62°F. and is supported by rollers placed under it to avoid flexure. There are several copies of it, known as Parliamentary copies. One is at the Royal Mint, another at the Royal Society, another at Greenwich and one at the Board of Trade. One copy is immured at the Palace of Westminster. What happens in practice is that the National Physical Laboratory periodically compares these copies, except the one at Westminster, with the Imperial Standard Yard. This must be done under the provisions of an Act of 1878. The last comparison was made in 1947-48. On this standard depends finally all the micrometers and gauges used in British industry.

Catalysts for British refineries

As the United Kingdom petroleum refining industry continues to grow, with new units coming into operation month by month, there is a comparable development of industries ancillary to oil refining. One of the most interesting undertakings of this kind was opened last month at Warrington. This is a refinery catalyst plant. It has been built at a cost of £1,000,000 and is being operated as a result of agreements between Joseph Crosfield & Sons Ltd., an associated company of Lever Bros. & Unilever Ltd. and the Davidson Chemical Corpn., U.S.A., and between Crosfields and five oil companies, Esso Petroleum Co. Ltd., Anglo-Iranian Oil Co. Ltd., Shell Refining & Marketing Co. Ltd., Trinidad Leaseholds Ltd. and Bahrein Petroleum Co. Ltd.

The main raw material in the manufacture of catalysts is sodium silicate, of which Crosfields are the major U.K. producers.

The plant includes two Swenson stainless-steel driers which have been fabricated in the U.K. under licence. These are the largest driers of this type which have been made. Because of the strict chemical and physical conditions which must be observed at all stages in manufacture the plant embodies some of the most modern methods of process control in the form of automatic temperature, pressure and flow controllers.

The Warrington plant, which is larger than the proposed Dutch plant (see p. 43) in terms of capital cost, will supply oil-cracking catalysts to the five oil companies in connection with their sterling area expansion programmes.

It is claimed that the production of this catalyst in the U.K. will save several million dollars annually. The catalytic crackers which need the catalyst are either already in operation or about to go into operation.

Large-scale chromatography

The majority of applications of chromatographic separation in the petroleum industry have been on a laboratory scale. The Sun Oil Co. is, however, to use its *Arosorb* process for the separation of aromatics by selective adsorption from the liquid phase in a plant to be built at the company's Marcus Hook refinery, the first large-scale application of chromatography in the refining field.

In this process, catalytic cracking is used to convert naphthenes to aromatics, which are then distilled to provide an aromatic-rich feed for the *Arosorber*. This unit incorporates six silica gel cases, 10 ft. in diameter and 20 ft. high, containing a total of 500,000 lb. of gel. Each case will go through 15 cycles daily, staggered so as to leave the rest of the plant in virtually continuous operation. The aromatic stream passes through the silica gel bed, resulting in the adsorption of the aromatics, until the bed nears saturation, when the feed is shut off and the bed desorbed by butane and mixed xylenes. When desorption is substantially complete the charge stock is readmitted and the cycle repeated. Final fractionation then produces the specification products.

For a feed containing 35% of aromatics, it is expected that the *Arosorb* process will require about 2 barrels of mixed xylenes and 0.5 barrel of butane per barrel of charge. Recovery of aromatics will be high, but will diminish to some extent at very high levels of purity, recovery at 90% purity being of the order of 98%, but at 98% purity only 90%. The new plant is designed to produce 13,000,000 gal. a year of benzene, 30,000,000 gal. of toluene and 15,000,000 gal. of xylene.

Maintenance in chemical works

A chemical works maintenance organisation must be able to direct on systematic lines all site maintenance and construction operations yet possess sufficient flexibility to deal effectively with the many technical problems inherent in the complexity of the plant and processes employed. This demands well-trained and experienced personnel, both chemists and engineers co-operating together and each contributing their joint scientific experience in mutual understanding.

The various aspects of the maintenance problem can be resolved into three main groups, technical, organisation and methods, and economics. In this manner, Mr. H. Birchall has dealt with the subject in a paper, 'Chemical Works Maintenance,' presented last month at a London meeting of the Chemical Engineering Group of the Society of Chemical Industry.

From the technical point of view, the most effective steps in preventive maintenance can sometimes be taken in the design stage. Very important in this stage are simplicity of operation and control, accessibility, ease of installation and removal of plant, ease of assembly, standardisation and provision of renewable wearing parts. The maintenance man whose technical background is not sufficient to develop technically the plant under his control is not likely to be an outstanding maintenance man, and the converse is true in the design field. Here works experience is of outstanding value in avoiding the design features which add to the cost and difficulties of works maintenance.

Co-ordination of effort of the many engineering trade groups forming the maintenance organisation is essential in order to minimise periods of non-operation. Not infrequently it happens that as many as seven different trades may be employed on a single site maintenance overhaul. Each trade has to be provided with the necessary tools and equipment, and with materials, some of which may be stored separately at central storage depots. Furthermore, the availability of men must coincide with plant availability. The maintenance engineer, therefore, is responsible not only for the initiation of all maintenance work, but has to collaborate with one or more plant superintendents. To the major problem of efficiently organising and deploying labour is added the variability of work which arises from the wide range of machinery and equipment in use.

With rare exceptions, chemical plants are designed to last a considerable length of time, say 15 to 20 years, or even longer and, consequently, it is exceptional that a policy of cheap maintenance is deliberately embarked upon. Attempts to do so on the grounds that plants are likely to become obsolete very quickly usually end disastrously, as production is often kept up over a longer period than originally anticipated and, once maintenance is allowed to fall below a certain level, deterioration is very rapid and high costs result. Nevertheless, maintenance costs much be kept under strict observation, and much money may be wasted unless a sound basis of planning is introduced, strengthened by an efficient technical organisation.

The setting up of an organisation to meet requirements clearly depends on the size of the factory and the complexity of operation. In a small manufacturing unit, high efficiency might be obtained by a single individual with the ability to control both maintenance and manufacturing operations. Irrespective of the size of the factory, the organisation should provide a near approach to the individual control of a small one. The broad problem, therefore, is two-fold:

to have fields of responsibility well defined and, at the same time, to encourage friendly relations between all levels of responsibility. A large chemical works which sets out to solve these two problems is on the right road to efficiently organised and technically advantageous maintenance.

Trends in chemical prices

STUDY of the price index of basic raw materials published by the Board of Trade reveals the steady increase in prices during the past two years. Recently the commodity price index numbers relating to a wide range of chemicals and plastics materials have been added to these lists. The index is based on a value of 100 on June 30, 1949.

Of the chemicals given, the price of industrial ethyl alcohol increased the most in two steps from 100 to 117.8 on October 1, 1950, and then to more than double, 237.8, on April 1, 1951, only six months later. The index for acetic acid also increased on the same dates to 111.4 and then to 184.3. An almost equally steep rise occurred with phenol, the index for which now stands at 171.4. The index for crude sulphur, as to be expected from the shortage, has also more than doubled to 202.8, as well as that for sulphuric acid which varies between 147.2 and 176, according to the grade. It is remarkable, too, to note that the index for carbon black, the large-scale manufacture of which was only started in this country in 1950, has also increased considerably, to 145.1, in fact.

The prices of most other chemicals rose by lesser amounts, the index for general chemicals now standing at 130.4. Calcium carbide appears to be the only chemical to have declined in price; its index stood at 91.4 on November 1 and some months ago it was as low as 87. The price for hydrogen peroxide has remained unchanged during the period.

In some cases there have been considerable increases in the price of basic materials for plastics. Polystyrene thermoplastic moulding powder shows the largest increase; its index now stands at 204. Cellulose acetate moulding powder and phenol formaldehyde are also much dearer, although the index for polyvinyl chloride has remained at 100 and that for urea-formaldehyde increased to only 115.1.

Food, fats and chemicals from whales

ALTHOUGH whales have been hunted for more than 1,000 years, the modern whaling industry dates from about 1925 when the factory ship capable of handling and processing these huge mammals was introduced. The astonishing development of these floating factories is illustrated by the description of the extensive equipment with which modern ships are fitted which appears in this issue.

The most important product today is undoubtedly oil, which is now largely used as a basis for margarine and soap. At present prices, its annual value amounts to £27,000,000. More recently the whale has become also a source of meat for human consumption, of protein and phosphates, and of hormones. Present investigations are directed towards utilising every part of the whale.

Previously, after cooking to recover the oil, most of the meat was disposed of as waste and only a small quantity was converted into dried meat meal for animal feeding. Now, however, all the meat and bones are processed. Since the war, the use of whale meat for human consumption has increased, and plans to bring larger quantities from the Antarctic involve either dehydrating or freezing. The whale meat as marketed in the shops today is not as tasty as desired and its palatability will have to be improved before it becomes as acceptable as beef and mutton. Apart from meat, an estimated amount of 160,000 tons p.a. of proteins and phosphates, at present not being used, could be extracted from the permitted annual whale catch. The processes involved are being studied, but the installation of the necessary plant on factory ships involves considerable practical difficulties. Other valuable products, obtained in smaller quantities, are liver oil containing vitamin A, and hormones, the most recent development in the latter respect being the collection of whale pituitaries as a source of the new anti-rheumatic hormone, ACTH.

Fertilisers and sulphur

SINCE Fisons Ltd. are among the biggest British fertiliser manufacturers, it was to be expected that in his annual review the chairman, Mr. F. G. C. Fison, should have a lot to say about the sulphur shortage. For Fisons the cut in supplies of American brimstone came at a particularly unfortunate time, almost coinciding with the opening of their superphosphates plant at Immingham, Lincolnshire (see INTERNATIONAL CHEMICAL ENGINEERING, July 1951, p. 315), which has been designed to operate on brimstone as a source of sulphuric acid. This decision was taken because, of course, a brimstone acid plant is much cheaper than one using pyrites and also because it produces heat required in superphosphates processing. Furthermore, according to Mr. Fison, there was no sign at the time of a cut in supplies of American brimstone, which had been freely and cheaply available for more than 30 years. The consequence of the cut in supplies is that Immingham has never been operated at more than two-thirds capacity.

Because they are intimately concerned with sulphur, Fisons have taken a leading part in the formation of the United Sulphuric Acid Corpn., which is to build the new plant for producing sulphuric acid from anhydrite at Widnes. In his review, Mr. Fison explained that, although normally anhydrite is not a commercially attractive source of acid, it is slowly shedding this disadvantage as brimstone and pyrites become dearer. However, he does not think that anhydrite, plentiful as it is in the U.K., is the solution to this country's sulphur problems. One reason for this is the high cost of the plant. Another is the need to find an outlet for the simultaneously produced cement if the project is to be economic. (These technical and economic problems of anhydrite acid manufacture are dealt with more fully in the article in this issue.) For these reasons, Fisons, with a number of other consumers of sulphur, have formed the Sulphur Exploration Syndicate, which is to prospect for sources of sulphur outside the United States. An extensive programme of exploration has already started with the approval of the British Government.

Another prospecting venture sponsored by Fisons is that for the development of the potash deposits of north-east Yorkshire. Exploratory drillings continue to show satisfactory results and ' there are indications that a considerably wider field can be worked for potash than had previously been thought possible.'

'I.C.E.' February

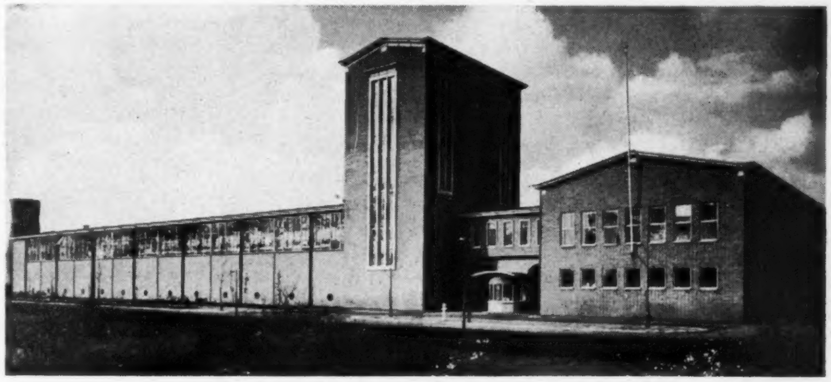
Articles will include: Filtration (an illustrated review); Advances in Coal Technology; Canadian Research on Chemical Engineering; Gas Industry Research.

New Facilities for Training Chemical Engineers in Holland

MODERN PILOT PLANTS AT DELFT TECHNICAL UNIVERSITY

By Dr. A. F. A. Reynhart*

Two new laboratories, one for unit processes and the other for unit operations have been built and equipped at Delft Technical University at a cost of 3,000,000 florins. They are the gift of industry and the Government in the Netherlands who have in this most practical way demonstrated their desire to raise the level of chemical engineering training in their country. The design and equipment of these laboratories is outstandingly modern and from this viewpoint they rank as one of the finest centres of chemical engineering training in the world. Here is a detailed description of the new facilities.



The new chemical engineering laboratories at Delft.

THE main centre in Holland for training chemical engineers is the Delft Technical University. In the past three years new facilities have been provided at Delft for the study of unit processes and unit operations. These laboratories, with their extensive modern plant and apparatus, have been donated chiefly by the Royal Dutch Shell who contributed 2,000,000 florins. A further 1,000,000 florins towards the cost of these facilities was contributed by Lever Bros. & Unilever, the Royal Dutch Salt Industry and the Government of the Netherlands.

The laboratories are fully provided with the necessary services such as power, steam, cooling water, vacuum, compressed air, etc., besides a maintenance workshop and a transformer station.

Unit operations

In what is known as the laboratory for physical technology, students are able to study unit operations. With the exception of a few large units, all the plant in this laboratory can be dismantled easily. This has been achieved by building platforms 30 m. long and $2\frac{1}{2}$ m. wide. Each can be erected at different heights on the 'meccano' principle. This flexible system of construction is very suitable for studying unit operations because, of course, each operation requires a different combination of apparatus.

The following plant and equipment are installed :

A calibrating device for measuring the flow of fluids up to a rate of 4 cu.m./hr. and gases up to a quantity of 10 cu.m./hr.

A mixing plant for pastes and powders.

A Buflovak evaporator in which several evaporation processes are combined. It consists of a double-effect vacuum evaporator, the second part of which has a forced circulation for the liquid which is to be evaporated. Any crystals formed are removed by a gate system. The plant can evaporate about 170 kg./hr. of water.

A Cande spray drier. This consists of a cylindrical atomising chamber with an accessory rotary atomiser equipped with a variable-speed regulator. The drying air is heated by a thermostatically controlled heater. This unit can dry such difficult substances as blood, milk, fruit juices, dyes, etc. Another advantage of the unit is that it produces very fine powders.

A film evaporator. This is a constant-flow evaporator consisting of a vertical steam-jacketed evaporator tube containing a rotating inner mechanism which controls the thickness of the flowing film of liquid. Its capacity is about 30 kg./hr. of water. This evaporator can be used in combination with the spray drier in cases where materials must first be concentrated by evaporation before being dried.

A gas absorption column, 40 cm. in diameter and containing six trays, 50 cm. apart, each fitted with two caps. The bottom of the column is connected to a ventilator with a maximum adjustable suction capacity of 1,000 cu.m./hr. and excess pressure of 50 cm. head of water. Besides being used for absorption and entrainment measurements, this column is also used for distillation.

Dorr-Oliver apparatus. This consists of various units for studying processes in which solid substances and liquids are treated, *e.g.* classifying, filtration, decantation, crystallising, mixing, milling, sedimentation and sifting apparatus.

TYPES OF REACTOR USED IN THE UNIT PROCESSES LABORATORY

Reactor for	*Number of phases in the reactor*	*State of aggregation of the phases*
Homogeneous reactions	1	Fluid.
Heterogeneous reactions	2	(*a*) Both fluid. (*b*) One fluid, one solid phase, non-stationary. (*c*) One fluid, one solid phase, stationary.
Heterogeneous reactions	3	(*a*) All fluid. (*b*) Fluid, one solid phase, non-stationary. (*c*) Fluid, one solid phase, stationary.
Heterogeneous reactions	More than three	(*a*) One fluid, more than one solid phase, non-stationary. (*b*) One fluid, more than one solid phase, stationary. (*c*) Fluid, more than one solid phase, non-stationary.

*Royal Dutch Shell.

Physical technology (unit operations) laboratory with its adjustable platforms.

Pilot plants for unit processes

In equipping this laboratory great attention was paid to the choice of apparatus for particular kinds of reactions. The object was to give the students the opportunity of forming a clear idea of the elementary demands made by a unit process as regards plant construction. It thus appeared best to stress the idea of reactor construction rather than that of unit process. In the first place the form and construction of the reactors must be decided when a particular chemical process is to be applied. Form and construction are generally determined by such factors as : (1) the number of phases present in the reactor, and their state of aggregation ; (2) the temperature at which reaction takes place ; (3) the pressure applied when carrying out the reaction ; (4) the thermal effect of the reaction as affected by the supply or discharge of heat and the stability of the process ; (5) the reaction rate ; (6) the physical properties of the base materials and reaction products during the reaction ; and (7) the chemical nature of the base materials and of the intermediate and final products in relation to the materials to be used, as regards corrosion and the effect of the corrosion products on the reaction and on the quality of the final product.

Special construction is also necessary in the case of :

Electrolytic and electrothermal reactions, which present problems of electrical insulation, sometimes necessitating the insertion or removal of solid electrodes.

Photochemical reactions, for which windows are necessary to admit the active radiation.

Biochemical reactions under the influence of micro-organisms, in which particular attention must be paid to ease of cleansing and sterilisation.

A classification of the various types of reactor used is given in the accompanying table.

Of course, the funds available were not sufficient to buy all types of reactor, so the choice was confined to a few of the most important types.

It was decided that the space available could best be utilised by building two permanent floors of open steel plates. The pilot plants consist of the following :

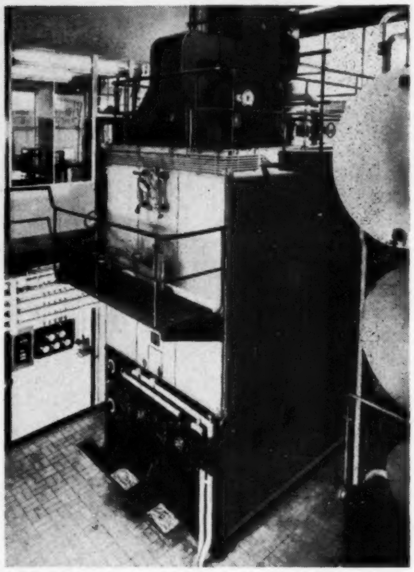
Chlorine-alkali electrolysis unit

This is a gift from the Royal Dutch Salt Industry. It consists of a vertical electrolytic cell of the type developed in Germany during the war as a variation of the well-known Castner mercury cathode process (see, *inter alia, Chem. & Metall. Eng.*, Jan. 1946, pp. 113-115).

The process is based on an iron disc which rotates slowly in a tray of rectangular cross-section and serves as a cathode. The tray, which is connected to the negative pole of the d.c. supply, is partly filled with mercury ; the remaining space is taken up by brine. Graphite anodes are passed through the side walls of the tray. Chlorine forms on these graphite anodes, while sodium dissolves in the mercury to form Na-amalgam. The mercury in which the sodium has been dissolved is pumped into a chamber in which the amalgam is decomposed into NaOH solution, hydrogen and mercury. The mercury regenerated in this way is then pumped back to the electrolysis cell. The NaOH solution is separated from hydrogen and is practically chlorine-free, a result of applying this diaphragmless system. The brine is also circulated by pumping. The solution leaves the cell via a separator, from which chlorine gas is liberated. The brine then flows into a reservoir filled with NaCl, after which the saturated solution is passed back to the electrolytic cell.

The plant is equipped with a Cuprox rectifier of 30 kW. capacity at 15 V. on the secondary side. The electrolytic cell has been provisionally built for a capacity of 1,000 A. which, if need be, can be raised to 2,000 A.

Production per hour amounts to about 1.35 kg. of NaOH and 1.2 kg. of Cl, using about 2.2 kg. of salt. This is the equivalent of 4 kg. of sodium hydroxide with 33% NaOH and 10 kg. of chlorine bleaching solution with 150 to 160 g./l. of active chlorine.



Steam boiler in the unit processes laboratory.

Fats processing plant

This plant is for the refining and hydrogenation of vegetable and animal oils and fats. A donation from Lever Bros. & Unilever N.V. made it possible to add to the plant equipment for processing oil seeds. This consists of :

A universal hydraulic press, supplemented by a rolling machine for crushing the seeds, and a device for heating the crushed product.

The universal press has been so constructed that, by fitting the relevant components, it can be modified for use as a **plate press, straining press** or **Anglo-American press,** with accessory moulding press and lifting device.

The presses can handle 25 to 40 kg./hr. of seed. The oil pressure is obtained from a hydraulic oil pump coupled to an air accumulator. The maximum hydraulic pressure is 400 atm.

An expeller of the Anderson type, which is used to produce oil from seeds by wringing. The capacity of the expeller

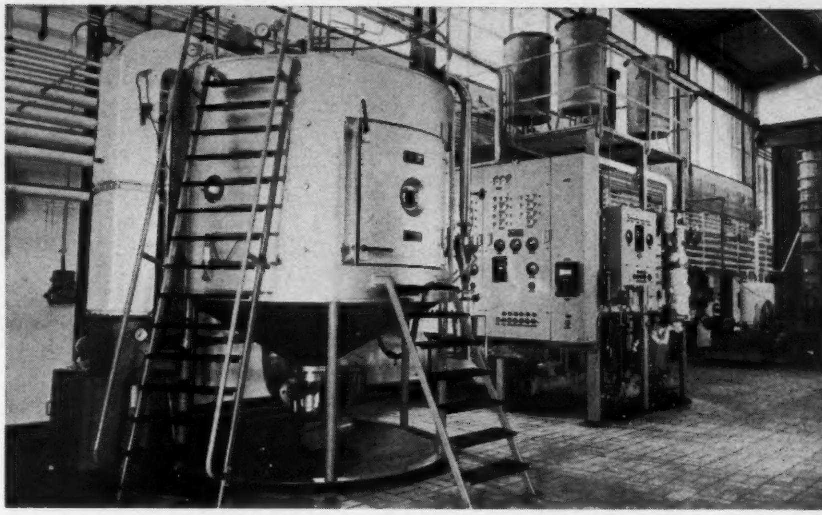
is from 120 to 250 kg./hr. of seed, depending on the type of oil seed.

A Soxhlet apparatus consisting of an extractor with filling space for about 100 kg. of base material. A still for the solvent has been built on to the extractor. The solvent is recovered by condensing the vapours from the still.

The crude oil may be obtained from oil seeds by various methods, using the apparatus described, which is suitable for processing nearly all industrially important vegetable seeds. Thus, in the sphere of vegetable oil production, unit operations can be investigated in practically any and every form.

Refining apparatus, with ancillary filter presses. In this apparatus the crude oil can be neutralised, bleached and deodorised, under an absolute pressure of 10 mm. Hg and at a temperature of 180°C. The vacuum in the deodoriser is obtained by means of a steam-jet ejector, the capacity of which is 30 to 35 kg./hr. of water vapour.

Hydrogenation plant, consisting of an autoclave suitable for use at not more than 200 atm. pressure and 250°C. (capacity 100 l.), with ancillary filter presses.



Spray drier, and, in the background, the film evaporator in the unit operations laboratory.

Plant for preparing catalysts

For the preparation of catalysts in general, apparatus has been installed in which precipitates can be obtained from the chemicals used. A concentration apparatus, in which the precipitate can be washed out and decanted, is also available. The precipitate is filtered off through a filter press and, if necessary, washed, after which the filter cake can be dried in an electric drying oven.

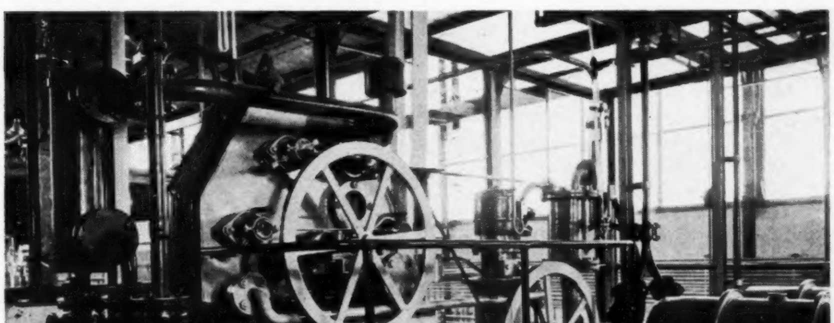
In addition, the following apparatus has been purchased for processing the dried filter cake : a **ball mill** for grinding the cake, which may, if desired, be thinned out with filling material ; a **cross-milling machine** for disintegrating coarser material; a rotating-type **pelleting machine** ; a **kneading machine,** fitted with a steam-heated mixing trough ; a **granulating machine,** with which various physical processes involving solid substances and pastes may be carried out ; and a **rotating reduction oven,** by means of which catalysts can be reduced with hydrogen and, after reduction, can be obtained suspended in oil. The reduction oven consists of a slowly rotating tube, the outside of which is heated electrically up to a maximum temperature of 600°C. The rate of rotation of the oven may be regulated. At 1 r.p.m. the mass remains in the oven for about 2 hr. and 13 l./hr. of catalyst are produced.

It will be seen that the plant is suitable not only for preparing catalysts but also for the investigation of many unit operations in which solid substances and liquids are treated.

Continuous high-pressure hydrogenation

This plant operates at a maximum pressure of 1,000 atm. at a temperature of 400°C. The hydrogen pressure is obtained by a five-stage compressor with a capacity of 10 cu.m./hr. of H_2. For continuous hydrogenation a circulation system has been devised in which intermediate circulation pumps have been incorporated and in which hydrogen is circulated through the reactor. The contact space in the reactor holds 0.5 l. ; the capacity of the circulating pumps is 13.5 l./hr. per pump. The quantity of hydrogen consumed is supplemented and measured by means of a pressure balance, while the pressure previous to application of the balance is recorded. After measurement by the pressure balance, the hydrogen is added to the base material, which is then passed into the supply line by means of the base material pump (capacity 1.6 l./hr.).

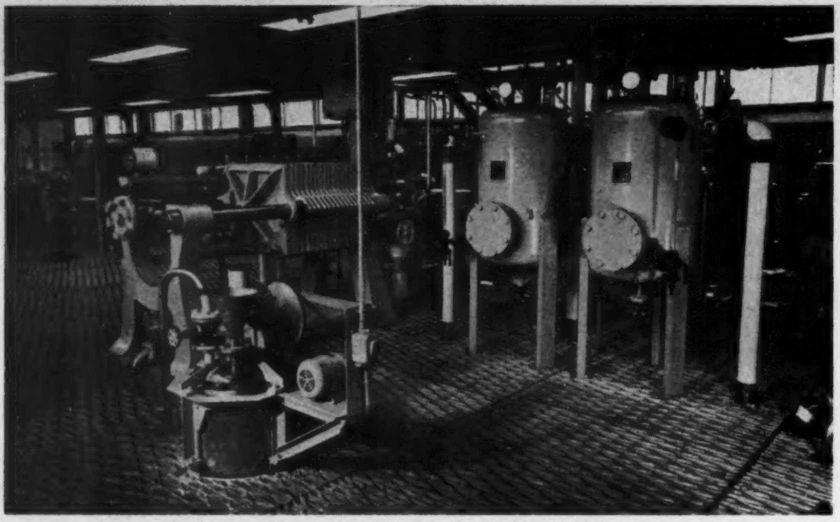
The mixture of hydrogen and base material passes through a preheater and enters the reactor. Liquid and gas leave the reactor, are then cooled, and separated in a separator. After this the liquid can be subjected to further treatment by itself ; the gas is drawn in by the circulating pump and put into circulation again. The quantity of hydrogen circulating is also measured with a pressure balance.



Electrolytic cell in the chemical technology (unit processes) laboratory.

Cement plant

This plant consists of an experimental rotary kiln and ball mills. The capacity of the kiln is about 25 kg./hr. of cement at a rotation rate of 10 r.p.m. It is heated by the combustion gases from an oil burner in the mouth of the kiln and the other side of the kiln is connected to a chimney. The requisite combustion air is preheated by means of 10 kW. resistance heating. Sixty cu.m./hr. of air are necessary to heat the kiln to a temperature of 1,600°C. The material for treatment is finely ground in a ball mill and then tableted by machine. The kiln is supplied with these tablets from the side at which the combustion gases are discharged. The product leaves from the side at which the burners are



Oils and fats refining equipment on the top floor of the unit processes laboratory.

Suppliers of plant and equipment

Chemical Technology (Unit Processes)

Chlorine alkali electrolysis plant : Koninklijke Nederlandsche Zoutindustrie, Hengelo, Holland.
Rotating reduction oven : Bosman N. V., Rotterdam, Analis, Namur, Belgium.
Rotary cement kiln : Smidth, Copenhagen.

Plant for Oils and Fats Processing

Rolling machine, universal hydraulic press, expeller, extraction apparatus and filter presses : F. Smulders N. V., Utrecht, Holland.
Autoclave for hydrogenation : Hadfields Ltd., Sheffield.
Refining apparatus : Wiener Co., Amsterdam and Korpershoek, Rotterdam.
Steam-jet ejector : N. V. Werkspoor, Amsterdam.
Continuous hydrogenation plant : Andreas Hofer, Mülheim a/Ruhr, Germany.
3,000, 1,000 and 200 atm. *compressors :* Burckhardt, Basle.
Membrane compressor : Corblin, Paris.
Gas storage tanks : Hollandsche Constructie Werkplaatsen, Leiden, Holland.

Plant for Preparing Catalysts

Dorr-Oliver apparatus : Dorr-Oliver Co. Ltd., Amsterdam.
Filter press : F. Smulders N. V., Utrecht.
Ball mill : Smidth, Copenhagen.
Electric oven : Smit, Nijmegen, Holland.
Granulating, tableting and kneading machines : Courtoy, Hall, Belgium.
Cross-milling machine : Peppink & Zoon, Amsterdam.

Physical Technology (Unit Operations)

Calibrating device : Chemisch Technisch Ing. Bureau Ph. J. Schuytvlot, Haarlem, Holland.
Mixer plant : Nauta, Leiden, Holland.
Evaporation plant : Buflovak Equipment Division, U.S.A.
Spray drier and film evaporator : Luwa A. G., Zurich.
Column : Own construction.
Equipment for classifying, filtration and crystallisation : Dorr-Oliver, Amsterdam.
Boiler plant : Nederlandsche Electrolas Mij., Leiden, Holland.
Vacuum pumps and air compressor : Dorr-Oliver, Amsterdam ; Lebrun Nimy, les Mons, Belgium.

located. The time spent by the material in the kiln can be varied by changing the angle of inclination of the kiln and the number of revolutions.

Miscellaneous apparatus

Three gas holders, each with a capacity of 2 cu.m., have been erected for storing various gases.

To enable experiments to be carried out in the pressure range above 1,000 atm. a super high-pressure compressor has been installed in which it is possible to carry out, on a small scale, measurements and investigations between 1,000 and 3,000 atm.

The compressor has a suction capacity of 1 normal cu.m./hr. of gas ; the suction pressure is 800 atm., the final pressure 3,000 atm. The piston of this compressor is driven hydraulically.

Other apparatus includes : a **piston compressor** for compressing ethylene to a maximum pressure of 200 atm., the capacity of this four-stage machine being about 12 cu.m./hr. of ethylene ; and a **membrane compressor**, with which gases can be compressed to a pressure of 8 atm. The capacity of this compressor is about 25 cu.m./hr. Accordingly, gases in a compressed condition, free from oil, can be obtained by means of this machine.

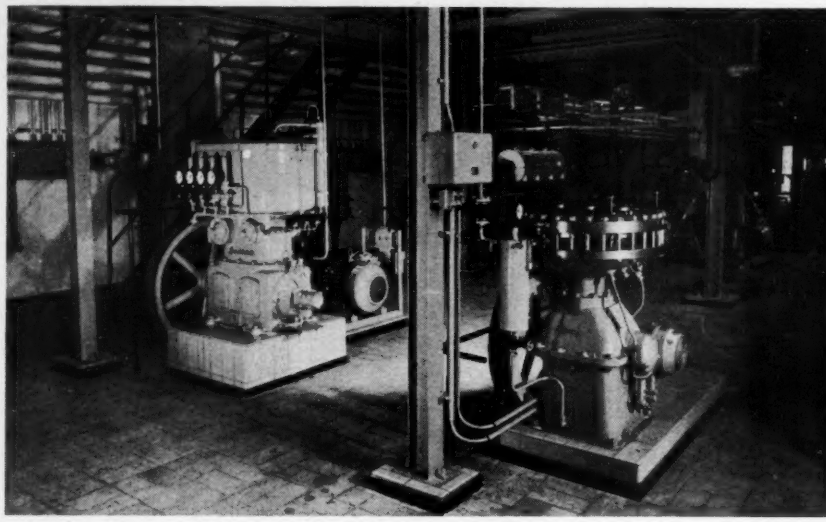
Services

The transformer station is equipped for a maximum load of 2,250 kW.

Both plants are provided with the necessary utilities, such as a steam supply, lighting, heating, cooling water, vacuum equipment, compressed air, etc.

An oil-fired boiler plant with a maximum capacity of 5 ton/hr. of steam at a pressure of 18 kg./sq.cm. has been constructed. It is possible to reduce the capacity to 25% of the maximum.

Lighting is provided by Philips TL fluorescent tubes and heating by warmed air.



Left, the ethylene compressor and, right, a diaphragm compressor in the unit processes laboratory.

A recycling system is planned for the cooling water supply, including a concrete cooling tower for the regeneration of the warm cooling water. The capacity of the cooling tower will amount to 50 cu.m./hr. of water to be cooled from 50° to 30°C. at an outside air temperature of 25°C. and a relative humidity of 65%. The warm cooling water is chilled in the cooling tower by a rising air current and pumped to the plants, where it is used for cooling condensers, etc. The used, and therefore warm, cooling water flows back into the cooling tower, thus completing the cycle.

Vacuum is maintained by means of two suction-type vacuum pumps with a capacity of approximately 370 cu.m./hr. per pump at an absolute pressure of 6 cm. Hg.

The compressed air supply is provided by a compressor with a suction capacity of about 180 cu.m./hr. The air pressure amounts to 7 kg./sq.cm.

Acid storage. Stoneware acid storage plants are described and illustrated in a new catalogue section issued by Hathernware Ltd.

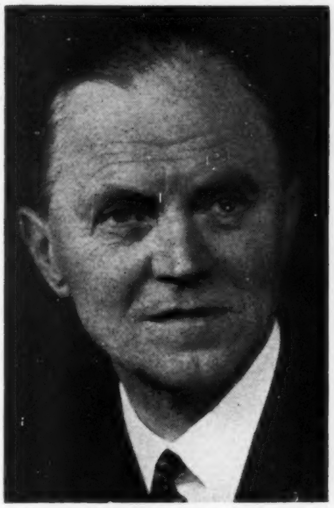
They are widely used on the Continent, and among the advantages claimed for them are the small storage space required, which can be easily extended, reduced or dismantled for moving ; no risk of loss or damage due to spillage or carboy breakages; easy filling and emptying ; maintenance of adequate stocks ; and easy cleaning, enabling the jars to be used for storing different liquors without fear of contamination.

Chemical Engineering Research: Britain's Needs and Resources

REPORT OF THE CREMER COMMITTEE

In April 1949 the Department of Scientific and Industrial Research appointed a committee under the chairmanship of Mr. H. W. Cremer 'To review the needs for research in chemical engineering and the extent to which they can be met by existing facilities.' Last month this committee published its report* and below we give extracts which set out the needs, examine the existing facilities, and list outstanding requirements for research for which there are no adequate facilities.

THE committee obtained the information upon which they based their report from answers to a questionnaire which went to university departments, government departments, research associations, nationalised industries and industrial firms carrying out or applying chemical engineering research. These replies are considered to represent the opinions of the majority of the important chemical engineering firms and allied interests. There were also contributions from the committee members themselves and from representatives of the following government departments: National Physical Laboratory, Mechanical Engineering Research Organisation, Board of Trade, the Fuel Research Station, Ministries of Supply and Fuel, and D.S.I.R. headquarters. Prof. Linstead, formerly director of the Chemical Research Laboratory, also attended meetings.



Mr. H. W. Cremer.

CHEMICAL ENGINEERING RESEARCH NEEDS

Scope of chemical engineering

Chemical engineering is based on the physical sciences and is concerned with the development, the design and the operation of plants in which materials undergo a change in properties. It will be realised, therefore, that its applications are not restricted to those industries in which chemical reactions are utilised but extend into almost every industry.

It is essential at the outset to realise the difference between chemical engineering and chemical technology. The chemical engineering approach to the task of applying scientific knowledge to industry is of a generalised character: the principles are all applicable to a wide range of special technologies. The special technologies are concerned with the *processes* of manufacture of *particular* products; chemical engineering is concerned with the study of *plant and operations* which are *generally and widely* applicable to all industries.

Essentially the business of the chemical engineer is to design and operate industrial plant. A large part of this is the task of deciding the 'leading dimensions' of installations required for a specified rate of output. Many chemical engineers are employed to operate existing plants at conditions of highest and most efficient performance. The chemical engineer may also have to choose suitable materials for the construction of the plant. It may also be necessary for him to bring to the mechanical engineer co-operating in the design and engaged in the actual construction of an installation a knowledge of special techniques.

In seeking to define the chemical engineering research needs of industry and the facilities available to supply them, we decided upon the following general classification:

Special chemical engineering subjects. (*a*) *Component and/or phase separation; based on physical and mechanical processes.*

System	*Typical operations*
Solid/solid	Sublimation, elutriation, sieving.
Solid/liquid	Leaching, extraction, sedimentation, filtration, evaporation, drying.
Liquid/liquid	Distillation, fractionation scrubbing, centrifuging.
Liquid/gas	Aeration, entrainment, scrubbing, dehumidification.
Solid/gas	Electrostatic precipitation cyclone-separation, absorption, diffusion.
Gas/gas	Liquefaction, selective absorption.

(*b*) *Formation of new components by chemical processes.* Design of plant for reaction in batch and continuous working followed by component and/or phase separations depending upon the physical operations included in (*a*).

Ancillary chemical and engineering subjects. In addition to the classifications under (*a*) and (*b*) above, heat transfer, fluid flow and size reduction, together with power generation, instrumentation and materials of construction, are subjects of direct interest to the chemical engineer.

The research aspects of the subjects included under the above classification from the chemical engineering standpoint are:

(*a*) Their mechanism;
(*b*) The principles underlying their integration into complete manufacturing units;
(*c*) The design of plant necessary for carrying them out efficiently on a large scale;
(*d*) Their economics.

Specific needs

Sources of information. The greatest need is for physical data in a form which can easily be translated into terms which are immediately applicable to the installation to be built. There is a very definite need for some form of technical information bureau. Many firms commented that existing research knowledge and data should be collected and published or should be readily available at some central reference point. It has been put to us that such a central technical bureau of information could be set up under the aegis of a suitable organisation with D.S.I.R. backing. We consider that this is an important point and that the proposal for some such service for chemical engineers should receive urgent consideration. One of the tragedies of the present time undoubtedly is that so much of the information which exists, possibly in obscure and unrelated form, is unknown to potential users.

On the evidence placed before us, such an information bureau is required to assist manufacturers and plant-designing firms

**Report of the Committee on Chemical Engineering Research.* H.M. Stationery Office, 1951. Pp. 36, 1s. 6d. net.

before they embark on lengthy and costly investigations and would materially assist productivity.

Simultaneously with this service, central indexing of information is also universally desired; also important papers should be critically reviewed.

On the question of publication of fundamental and technical data, including such information, for example, as performance data on British pumps, the opinion was expressed that the publication of a British chemical engineering handbook would be timely and that the publication of a really comprehensive volume or series of volumes on the principles and practice of chemical engineering should be encouraged. With these opinions we agree.

Functional analysis. There is a tendency in the chemical engineering literature to assume, a little too lightly, that the chemical engineer can readily obtain answers to all his questions from the results of fundamental investigations. This is, no doubt, a state of affairs which everyone would like to achieve, but it would be fair to say that this mental attitude is altogether inconsistent with actual facts. The simple truth of the matter is that practically all industrial installations, many of which work at relatively high efficiency, have been developed empirically. As an example, we would refer to the vacuum pan invented by Howard and patented in 1817. In this type of development it must be admitted that industry has outstripped the scientist by at least 50 years. Similar examples could be given from almost every branch of chemical engineering activity.

It is therefore important to recognise that there are two quite distinct approaches to the problems of plant design. On the one hand we have what might be called the 'synthetic' approach, based upon an endeavour to establish by physical measurement the influence of each variable entering into the problem. On the other hand, what is equally required is the 'analytical' approach, in which accumulated physical knowledge is applied to existing plants in order to trace the relative importance of the variables and to ascertain why trial and error has resulted in satisfactory operation. In order that there shall be no misunderstanding it must be stated that the practising chemical engineer knows by experience that if he were to calculate the leading dimensions of a plant from available physical data—even from data given in the chemical engineering reference books—the answer would very often be wrong. Far too often he is in the unsatisfactory state of mind of knowing from experience that the theoretical calculations are wrong but of not knowing why they are wrong. It is therefore suggested that, although it is desirable to encourage investigation on synthetic lines, it is also urgently necessary to foster the analytical approach, *i.e.* that an attempt should be made to build the bridge between the theoretical scientist and the plant designer from both ends.

The Cremer Committee

Mr. H. W. Cremer, C.B.E., M.Sc., F.R.I.C., M.I.Chem.E., M.Inst.F. (*Chairman*)
Prof. T. R. C. Fox, M.A., M.I.Chem.E., M.I.Mech.E.
Prof. F. H. Garner, O.B.E., M.Sc., Ph.D., F.R.I.C., M.I.Chem.E., M.I.Mech.E.
Mr. H. Griffiths, B.Sc., A.R.C.S., F.R.I.C., M.I.Chem.E.
Dr. N. P. Inglis, Ph.D., M.Eng., M.I.Mech.E.
Mr. Norman Neville, O.B.E.*
Prof. D. M. Newitt, Ph.D., D.Sc., B.Sc., A.R.C.S., M.I.Chem.E., F.R.S.
Mr. J. A. Oriel, C.B.E., M.C., M.A., B.Sc., F.R.I.C., M.I.Chem.E., F.Inst.Pet.†
Mr. J. Davidson Pratt, C.B.E., M.A., B.Sc., F.R.I.C., M.I.Chem.E.
Mr. S. Robson, M.Sc., D.I.C., F.R.I.C., M.I.Chem.E., M.I.M.M.

* Upon the death of Mr. Norman Neville, his place was taken by Dr. E. H. T. Hoblyn, M.B.E., Ph.D., A.R.C.S., D.I.C., F.R.I.C., A.M.I.Chem.E.

† Owing to the protracted ill-health of Mr. Oriel, his place was taken by Mr. E. Le Q. Herbert, B.Sc., F.R.I.C., F.Inst.Pet.

Most replies to our questionnaire emphasised the importance of the functional analytical approach in chemical engineering research. We noted that many firms drew attention to the fact that often new factors appear in practice which have not been taken into account in the synthetic approach to design. A well-known example of this is in the performance of packed towers where possible maldistribution (channeling) of the flow of the fluid media emerges as a factor of increasing importance with increase in the size of the plant.

We have had an opportunity of discussing the attitude of the universities to functional analysis. While realising the practical difficulties of carrying out this type of investigation in a university chemical engineering department, we consider that it might be possible to do so by suitable arrangements with industry.

With regard to British industry, it was represented to us that not enough effort was being put into making a smoothly running plant function better by analysing its performance characteristics and that it was only when a plant failed to function properly that it was studied closely. In other words, cases of under-design invariably receive active attention, but over-design, *i.e.* where sections of a plant are too large, is quite often overlooked. This seems to suggest that more tests of installed equipment should be undertaken.

We are of the opinion that functional analysis not only has an immediate value as a design tool, but that it is of even greater long-term importance in that it leads to the development of new theories related in an increasingly close manner with observed phenomena under actual plant conditions. To this extent we find there is an urgent need for close integration of research, plant design and manufacturing operation.

Particular subjects for immediate investigation. (*a*) *Mass transfer*. Many problems were presented to us in this field. Outstanding among these was the plea for more research on the theory and practice of agitation, mixing, blending and kneading. These operations are of major interest to so many industries that we can fairly describe such work as a paramount need. In the chemical industry itself, an almost equally high place was given to the need for information on the design and operation of packed towers used as absorption or scrubbing towers or as fractionating columns.

(*b*) *Heat transfer*. So varied and numerous were the demands under this heading that we consider that the precise needs can only be specified after the preparation of a survey of current practice. If this be undertaken the literature survey now being prepared in the Heat Division of the Mechanical Engineering Research Organisation, as a prelude to the further development of its research programme, may well be found to be of service.

From our own more general survey it appears that the following are among the more urgent needs:

Heat transfer work on: (i) Viscous fluids; (ii) 'fluidised' solids; (iii) condensing vapours in the presence of non-condensible gases (no data are available for other than air and steam under atmospheric pressure); (iv) with the increasing use of tonnage oxygen for the burning of fuels in oxygen or oxygen-enriched air, gas radiation data for steam and CO_2 at high temperatures should be collected and made available.

(*c*) *Solid and liquid separation*. We feel that the functional analytical approach could well be applied to existing methods of solid separation in order properly to reveal the nature and significance of problems which still remain unsolved. For example, it would be of value to carry out a detailed investigation into the performance factors of various types of separation units in order to assess their scope. Among particular methods, the research on centrifugal separators could well be extended, while more exhaustive work should be carried out on the design and performance of cyclones, gravity impact separators and on electrostatic and ultrasonic methods of separation.

(*d*) *Size reduction*. Although much work has been done in this field there are, nevertheless, certain basic problems on which fundamental data are either lacking or obscure. In particular there would appear to be a need for further research on the phenomenon of over-grinding. This may, of course, involve work on classifiers—that is, means of ensuring that the coarse particles return to the mill—and on scavenging, *i.e.* ensuring that the fines are removed from the mill.

Plant development. One of the most strongly felt wants in this field is that of data whereby design problems could be

solved more simply than at present. Our attention has been drawn to the need for a thorough investigation into the problems of 'scaling up' from laboratory-scale through intermediate stages to full-scale plant.

Ancillary needs

Instrumentation and automatic control. Owing to the tendency towards the adoption in process work of automatic control, designers of chemical plant are finding it necessary to design their plant around the instruments and associated control gear. A lack of instruments might lead to an entirely different design of plant, and we therefore believe that more intensive research in the design of instruments for process control should be treated as a matter of great urgency.

Erosion and corrosion. This question is so closely associated with the choice of materials of construction that our views on corrosion are given at length in the section below dealing with materials. Since corrosion is a universal problem, the needs for research in this field are very urgent.

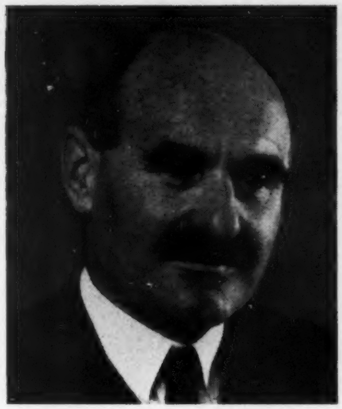
Materials of construction. The need for further work to find really satisfactory chemically-resistant plant linings and for the development of cheap easily-worked corrosion-resistant alloys are two points to which our attention was specially drawn by the chemical industry. There is a large volume of research going on in this field which requires co-ordination.

We consider that there should be a review of materials generally available in Great Britain, containing the relevant physical data and including data on corrosion resistance to the materials in common use in industry. It has been represented to us that a series of tables containing data collected from users of materials of construction for plant and auxiliaries would be of great help to the smaller firms in the development stage of chemical processes. In this connection, as in others, we have learned with satisfaction that a number of the larger concerns in the chemical and allied industries are prepared to provide such data and, in fact, some are already being published. We are of the opinion that it is preferable for the collection and publication of such data to be done by an independent body.

Effluent treatment. On such a subject as effluent treatment, including particularly the elimination of dusts, mists and smokes, we consider that there are problems common not only to a number of firms but also to a number of industries. The disposal of such effluents as those stated above is of importance not only from the industrial side in the recovery of valuable materials but also from the viewpoint of health and hygiene. The cost of effluent treatment is high and research in this field offers the possibility of much reward.

Economics

Reference should be made to the economics of research and development, in view of its bearing on the subject. The current expenditure on research and development in the British chemical industry compares favourably with other industries in this country. It is not known, however, what proportion of this is devoted to chemical engineering research, but in all probability it is too small. There is an urgent need for firms of all sizes to spend more on development.



Prof. D. M. Newitt, F.R.S.

CHEMICAL ENGINEERING RESEARCH FACILITIES

1. Universities and technical colleges

The universities should obviously be one of the primary sources of fundamental research, the results of which are normally published.

Birmingham University and Imperial College have by far the largest chemical engineering departments and more research is in progress there than in the other university or technical college chemical engineering departments.

Nevertheless, a very much greater research effort is called for and no opportunity should be lost of calling for the urgent expansion of all existing university and technical college facilities as soon as possible. The recently endowed Chair of Chemical Engineering at Cambridge should have a great future research potential. But however great this expansion may be, it must still be borne in mind that it can, by reason of the limitations imposed by academic considerations, only deal with one phase of the problem. Research at universities has as its primary object the training of students in the conduct of research. Although many of the investigations are excellent in their own way, the results are frequently presented in a form which is not suitable for the chemical engineer who has to give an answer to a practical problem immediately in order to enable his work to proceed.

It is important that nothing should be done to discourage the fundamental research work, but it is desirable to have a clear appreciation of the practical implications of such work.

2. Government departments

The generally available chemical engineering research facilities are confined to a very few establishments. For example, the Chemical Research Laboratory, the Fuel Research Station and certain divisions of the National Physical Laboratory, while not having chemical engineering departments as such, carry out a good deal of work in this field, or research which is ancillary to chemical engineering. The Mechanical Engineering Research Organisation, which is building a new heat transfer research laboratory for work on all types of heat transfer, may well constitute an important facility so far as long-range work is concerned. An expansion of effort and possibly a redirection of work would provide additional research facilities.

The Defence Departments, on the other hand, have certain establishments which contain chemical engineering research laboratories. Although non-secret material may from time to time be made available for general publication, security considerations will undoubtedly prevent any large-scale utilisation of these facilities for general research.

3. Research associations

A number of the industrial research associations have chemical engineering sections and, in some of these, facilities exist for laboratory-scale and pilot-scale research. Of the 40 associations in existence, less than a quarter have such facilities at present. A few of the newer research associations intend to develop chemical engineering departments, and this is an encouraging sign. Nevertheless, if all these facilities were expanded, the very nature of a research association necessarily means that chemical engineering research must be directed to the particular industry and will therefore have specific rather than general objectives.

We appreciate that the *chemical* industry is too diffuse to have a central chemical research association, but it has been suggested to us that a *chemical engineering* research association would have a much smaller diversity of interests and yet be of service to the whole industry. This is a possibility which cannot be ignored.

4. Independent institutes and private laboratories

Several independent and self-contained chemical engineering laboratories exist which have laboratory- and semi-technical-scale plant facilities. The results of the research carried out on a repayment basis for individual clients are, however, not generally published. Nevertheless, these laboratories are of value in that they are able to some extent to bridge the gap between research and production, particularly for the smaller manufacturing firm.

5. Nationalised industries

The National Coal Board has so far the largest chemical engineering department of

these industries and is working on problems which will have a general interest to a number of other industries. It is presumed that the results of these researches and of those carried out under the auspices of the British Electricity Authority and the Gas Council will be made available generally.

6. Industry

A number of firms in the chemical, chemical plant and petroleum industries are doing fundamental and applied research on various aspects of chemical engineering. The results obtained by private firms are specific to their own problems and products, although they have in general no objection to the publication of any fundamental research they may carry out. Several firms have, in fact, expressed their willingness to supply fundamental data, to make available research results which would elucidate the general principles of engineering design and, in certain cases, to publish results of a purely technological nature where these results would give direct assistance to the manufacturers of chemical plant.

7. Other facilities

(a) Commonwealth facilities. The existence of Commonwealth Scientific Liaison Officers in this country affords an opportunity of obtaining results of current Commonwealth university and Government chemical engineering research. We have also observed with interest the setting up within recent years of chemical engineering divisions in several of the Commonwealth prototypes of the Department of Scientific and Industrial Research.

(b) Organisation for European Economic Co-operation (O.E.E.C.) At the present time discussions are being held in Paris as to the possibility of co-operative research and development between the various European countries concerned. To enable us to take a lead in any such future work, British research facilities must be increased, especially in the chemical engineering field, and we feel that this is an added reason for stressing the urgency of expanding university and Government research facilities.

OUTSTANDING REQUIREMENTS FOR RESEARCH FOR WHICH THERE ARE NO ADEQUATE FACILITIES

Mass transfer

Mixing and agitation. Although some work on this subject is being done, it is essential that a general attack should be made on the basic problems of mixing and agitation of liquids, pastes and solids, and that the underlying principles be investigated. This would best be carried out at a central point. There is, at the present time, no laboratory which can give the necessary amount of time and effort to this most fundamental problem.

Drying. In this case research is proceeding in a number of centres. Nevertheless, there are important problems which are not being covered. In this field, as in mixing and agitation, the interest of the various industries concerned could well be centred in one establishment in order that fundamental research into the interrelationship of drying problems of all types of material could be investigated.

Crystallisation. A certain amount of work is proceeding concerning various aspects of crystal formation. No concerted efforts appear to have been made to relate the mechanism of crystal formation in general to plant design.

Distillation. Here again, although a considerable amount of work is being done, no one laboratory appears to be attempting to undertake the correlation of all information in order that quick methods of calculation should be evolved with a view to determining the performance of fractionating columns.

Counter-current washing. Although much work has been and is being done in industry and elsewhere, there is room for much more investigation. In particular, if a central organisation were to co-ordinate the results which have been obtained in a wide range of industries and to attack common problems still outstanding in this field, considerable benefits would accrue.

General mass transfer problems. (*a*) *Spray research.* There is, especially from the chemical plant manufacturers' point of view, an urgent need to obtain fundamental data on (i) spray production, for instance the relations between physical properties of the liquid, power requirements and spray characteristics, and (ii) the utilisation of spray, for instance for cooling and gas washing. Although some work is being undertaken, it is mainly of a specialised nature and again a central organisation is required to co-ordinate all the various interests in this particular field.

(*b*) *Fluid flow.* Whilst liquid handling still presents many problems in this field, interest is being diverted to fluidised flow in particular. Although a certain amount of work is being carried out in Government research stations and in industry, much greater effort is required, especially from the design point of view. In the field of drying, for instance, there is practically no fundamental information on processes of drying materials while being conveyed by an air stream.

(*c*) *Pressure drop.* This is an urgent problem in which there is apparently a large gap in research; for example, data on pressure drop in pipelines and pressure drop involving angular flow and change of direction on a variety of gaseous and liquid components are required. Here again, although research is being undertaken in various places, nevertheless we feel that a central organisation would be in a much better position to review the whole field and to co-ordinate present work, as well as to fill in the various gaps which are not covered by existing research.

Heat transfer

The whole subject of heat transfer, it has been suggested, should be covered by a practice survey coupled with the existing literature survey. It is of special importance to have information of particular cases which do not follow the general rule.

Urgent information is required, from the design point of view, on the effect of non-condensible gases in vapours during condensation of these vapours and their effect on heat transfer.

Solid and liquid separation

Extended work into the performance of the various types of filters and separators would be of great service to the chemical industry generally. In particular the separation of fine powders from their suspension in the air, and the efficiencies and scopes of the various types of separators should be undertaken by a practice survey which could obtain statistical information on a wide range of separation plant.

An important example in the sphere of liquid separation is the dewatering of, or expression of the more valuable fluids from, bulky organic materials such as macerated leaves and seaweed, fruit pulp and peat, where a field exists for research on appliances such as roller presses and screw expellers. Another aspect, and one brought to our attention by the Rothamsted Experimental Station, is the extraction of protein from grass. In this connection the necessity has been pointed out to us for an examination of the chemical engineering operations involved in this and in biochemical problems in general. With the growing interest in biochemical technology, problems involving these and similar liquid separations will arise with increasing frequency.

Development of plant

Under this heading we are anxious that research should be undertaken on the problem of scaling up, and on the associated types of problem involved. This study of scale effect could very well be undertaken with a functional analytical approach. No existing organisation is capable at the present time of undertaking a general survey and study of the various effects concerned with the scaling-up problem and, although isolated attempts are being made to deal with individual cases, only a central organisation can effectively undertake a major programme of research which would be of benefit to industry in general. At the present time very little effort appears to exist outside specialist firms in industry.

For example, the design of gas and vapour lifts over a wide range of tube dimensions, liquid properties, pressures and so on should be studied. This has a fundamental bearing on the operation of evaporator tubes and other heat transfer problems and is also of direct interest for liquid handling. Also in this field is the necessity for concentrated attack on liquid/liquid extraction plant design. Here again

information, as stated above, will be available later in the year from the Ministry of Supply and, although this is valuable, it may be somewhat limited in scope for the particular problems we have in mind.

Our attention has been drawn by the Director of Food Investigation to the fact that D.S.I.R. at present contains no facilities whereby discoveries made in the research stations under his direction can, in appropriate cases, be carried forward to the pilot-plant stage, thereby opening up the way for their industrial utilisation. We regard development work of this kind as being particularly necessary in order that the full benefits of research in this highly important field may be more speedily realised. Our opinion is that such work could best be performed at a central laboratory, where the various problems could be co-ordinated with items of a similar character arising from other directions.

Other problems

Instrumentation. We wish to draw attention to the many requests for increased research in instrumentation in this country, particularly from the point of view of plant control and its associated problems. Although we are aware of the research being carried out in this field, we feel that much greater impetus should be given to the design of robust control mechanisms.

Corrosion and erosion. In this field it is essential that all the information available should be published and that relevant data concerning British materials should be collected into one place; also that there should be a central organisation controlling corrosion research. It is understood that this matter is under discussion by D.S.I.R. at the present time.

Materials of construction

Here there is a wide range of research which is being actively pursued. Marginally, however, there are many problems which appear to be neglected. Thus, whereas the various suppliers are primarily concerned with producing constructional materials in their respective fields, there is need for careful integration of the physical and chemical properties of these materials with their application in the actual construction of process equipment. Such work, carried out impartially by a central chemical engineering research station, it is felt would result in better utilisation of existing materials of construction, not only in meeting conditions of corrosion and erosion, but also those in which maximum heat transfer, for instance, is essential.

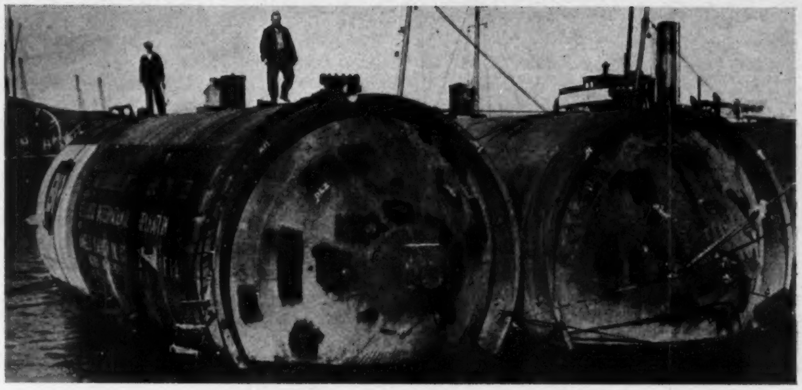
The foregoing is the bulk of the committee's report. In addition, there is a section of 'Conclusions' which are summarised in our 'Topics of the Month' section. There are also four lengthy appendices:

A *gives the substance of the questionnaire which was circulated, together with a list of sources from which opinions were obtained.*

B *is a classified list of chemical engineering research needs, as expressed by industry; this has the following main headings: mass transfer, heat transfer, design and construction of plant, materials of construction, instrumentation and automatic control, size reduction, solid separation, corrosion and erosion, absorption, effluent treatment, extraction, evaporation, scaling up, storage, and general.*

C *is a list of organisations with chemical engineering research facilities, including universities, Government departments, research associations, nationalised industries and private industry.*

D *is a list of chemical engineering research facilities under the subject headings in appendix* B.



TANKS FOR CATALYST STORAGE
Three 35-ton tanks for the catalytic cracking plant at Anglo-Iranian's Llandarcy refinery in Wales were recently towed by sea from Glasgow to Swansea. They will be used for catalyst storage.

Flotation of Diamonds

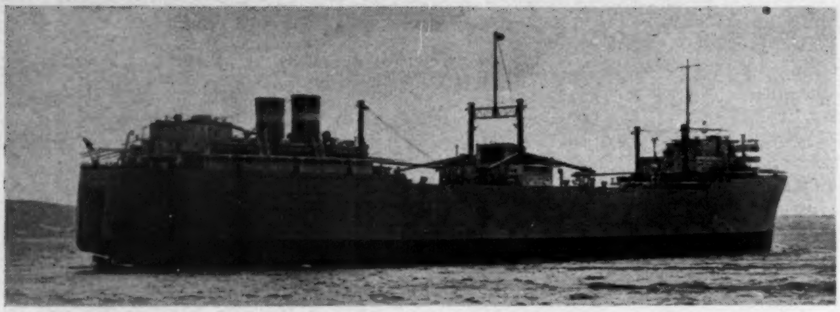
THE Diamond Research Laboratory in Johannesburg is investigating improvements in metallurgical practices for diamond mining companies, especially increased recoveries of the smaller industrial stones. Considerable work has been done on the possible application of flotation processes to the diamond industry and some details are given by R. G. Weavind, I. Wolf and R. S. Young in *Mining Engineering*, July 1951.

From the viewpoint of recovery processes, diamonds in their natural state may be grouped into two classes, the water-repellent diamonds which adhere to a greasy surface, and the water-avid diamonds which, because of their wettability, will not adhere to a greasy surface and must be recovered by means other than the grease tables used for water-repellent diamonds.

Experiments in the flotation of small diamonds from both kimberlite and alluvial deposits indicated certain conclusions. In the case of water-repellent diamonds, satisfactory flotation of 16 mesh diamonds, which are naturally water-repellent, may be accomplished using either *Aerofloat* 25, together with cresylic acid, or Du Pont B23 as frother, together with kerosene as auxiliary oily conditioner or froth stiffener. The quantities of reagents required are of the order of 0.15 lb./ton *Aerofloat* and 0.18 lb./ton cresylic acid. The use of acid circuits is detrimental, and for best results a *p*H between 7 and 9 should be maintained. A flotation period of 5 to 10 min. is necessary to ensure that all floatable diamonds are removed. Diamonds larger than 16 mesh cannot be recovered satisfactorily by flotation. Xanthates do not act as collectors for diamonds, and this is probably associated with their inability to impart a water-repellent surface to this mineral. Water-repellent diamonds smaller than 28 mesh can be floated quite well by the addition of a frother alone, such as pine oil.

In the case of water-avid diamonds, partial flotation of the smaller sizes of wettable diamonds can be achieved by preconditioning with fatty acids soaps, cationic amines and similar reagents, which will impart a water-repellent film to diamonds. Washing to remove excess reagent, followed by flotation, will result in a fair recovery, but the latter is much lower than for water-repellent diamonds.

Recovery of crushed boart from the waste products of industrial uses is best accomplished by first conditioning the diamonds present in the mixture with fatty acids, cationic amines and other conditioners, removing the conditioning agent by washing, and floating in a cell of the pneumatic type. Flotation reagents found to be most suitable are Du Pont B23 and *Aerofloat* 25 together with cresylic acid. The optimum quantities are 1.2 g. Du Pont B23, and 0.55 g. *Aerofloat*, plus 1.4 g. cresylic acid, per litre of pulp in the cell. A solid-to-water ratio of 1 to 4 is found to be the most suitable, and alkaline circuits are necessary for best results. Diamonds larger than 28 mesh are not recovered satisfactorily by this procedure, but for finer sizes flotation offers an excellent procedure for the reclamation of this strategic industrial material.



Processing Plant of a New Whale Factory Ship

The traditional sources of whale oil are the blubber, the fat meat and the bones. It is now possible to obtain oils from other parts of the whale known as Grax, the lean meat and the liver. This advance in whale processing has been made possible by the development of special equipment including expellers, vibratory screens, vacuum driers, coagulating chambers, tube driers and solvent extractors. Here is a description of the latest factory ship thus to be equipped, the 23,000 tonner, 'Juan Peron.'

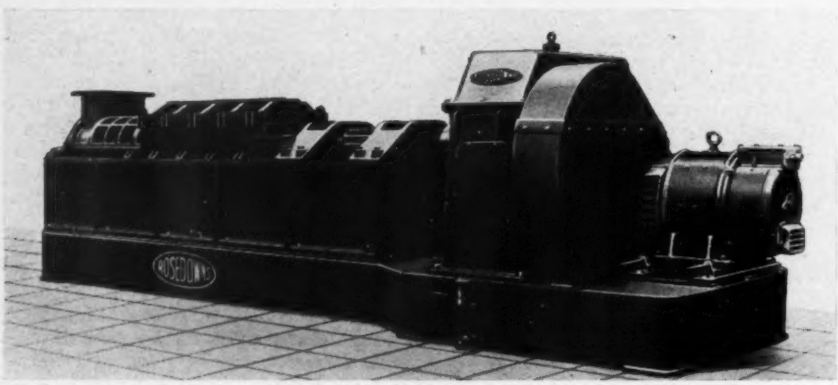


Fig. 1. G.X. Expeller—a special continuous double-screw press for high moisture content materials.

THE shortage of oils and fats has given a great impetus to improvements in the methods employed in winning these substances from available raw materials, and to the development of new, and the expansion of existing sources of supply. Particularly marked improvements have taken place in the treatment of the whale to obtain not only edible oils but also high vitamin content liver oils and high protein feeding meals. The latest factory ship to be designed and fitted out for this work is the 23,000 tons *Juan Peron* which has been built at Harland & Wolff's shipyards, Belfast, for the Compania Argentina de Pesca, and carries in her factory decks the latest equipment for dealing with a greater proportion of the whale than has hitherto been undertaken.

The number of whales which can be caught during the fixed catching period of 14 weeks is limited by international agreement, and the allowance for the *Juan Peron* is 20 blue whale units per day. One unit is equivalent to one blue or two fin whales, or 2½ hump back whales or 6 sei whales. This limitation is accepted as a wise precaution, and the industry is, therefore, concentrating on methods of treatment which will extract as many of the valuable commodities which can be obtained from the whale as space permits.

The annual production of whale oil obtained in recent years does not equal the production of pre-war years, when more ships were in action. Since the modern factory ship makes more use of the available resources we can assume that there is room for further expansion of the world's whaling fleet without danger to the whaling population, but it is important to realise that further expansion must be integrated with developments towards the full utilisation of all the useful commodities which can be obtained from the whale.

Since whaling grounds are generally in remote areas and, since processing of the whale must be carried out as quickly as possible after killing, the development of treatment methods is necessarily centred on the floating factory. This fact provides self-evident limitations to full expansion

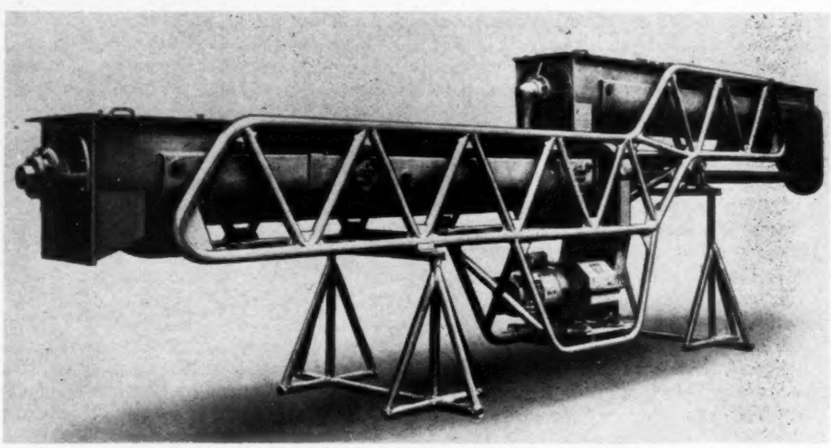


Fig. 2. Treatment tubes for preliminary treatment of whale meat.

and due to the confined space available and the need to conserve steam and power, certain processes have to be omitted or curtailed. In designing a new vessel the whole position must be reviewed in the light of market demands for the various products and the space and facilities which can be allocated to treating each commodity.

Capacity of plant

The equipment on board the *Juan Peron* has been designed with these factors in mind, and provision is made to allow some variation in the processes as occasion demands. The ship is capable of handling up to 2,500 tons of raw material per day, including 320 tons of lean meat, 200 tons of Grax and 15 tons of raw liver. One section is devoted to the more traditional sources of oil, the blubber, the fat meat and the bones, but this article is concerned with those sections which have developed more recently and handle the residual solids and entrained liquors from the blubber and fat meat sections, which are known as Grax, the lean meat and the livers. The plants for these sections have been designed and supplied by Rose, Downs & Thompson Ltd. of Hull.

A special contribution to the efficiency of the *Juan Peron* as a factory ship is made by the Grax plant, which reclaims valuable oil that would otherwise be wasted. The equipment includes special screens which can remove a large proportion of the free liquor before the material is passed into low pressure liquor expellers (of the type shown in Fig. 1). These expellers are designed to extract a large percentage of liquor from high moisture content materials. The liquor, containing oil, is screened and the oil reclaimed by centrifugal separation and purification together with the oils from the blubber and fat meat. Although the expelled solid residues, which can be converted into a nutritious feeding meal, are discharged to waste because there is insufficient space available to treat them, the reclamation of the oil alone amply justifies the space devoted to this work; at the same time, provision is made to conduct experiments on the treatment of the solid residues from the oil expellers, and experiments will be conducted to lessen the amount of bulky plant now carried, thus giving space for additional plant.

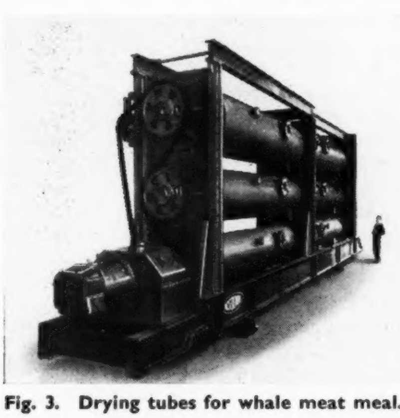


Fig. 3. Drying tubes for whale meat meal.

Lean meat plant

The lean meat can be treated on the *Juan Peron* to yield a feeding meal, and an oil which is equivalent in quality to the blubber oils. The meal produced contains a minimum of oil and has a high digestible protein content giving a very high value as feeding stuff. This plant includes equipment for preliminary reduction and oil separation; sterilising and drying; cooling; grinding and bagging. The reduction is carried out in Hoggers which pulp the material to a consistency which, after a further preliminary treatment, facilitates oil expression. Magnetic belts are employed to remove the harpoon shrapnel and other tramp iron which may come in from the flensing deck. The reduced meal is cooked in special treatment tubes (Fig. 2) before it is fed to vibratory screens and low pressure expellers of the type used in the Grax section (Fig. 1). Oil, blood, lymph and water are removed from the solids by the expellers and vibratory screens; the oil is reclaimed from these liquors by screening, separating and purifying. The removal of the liquors not only recovers valuable oil previously lost, but achieves considerable steam and power economy in the drying of the expelled solid residues which is carried out, after sterilisation, in tubular vacuum drier units. (Fig. 3 shows one of these units erected in the maker's workshops; when complete, the sterilising tube is mounted above the drying tubes.) After drying, the hot meal is passed through cooling tubes which bring it to a condition which will permit efficient grinding and bagging. As a safety precaution the cooled meal is passed over magnetic belts before passing to the combined grinder and cyclone unit.

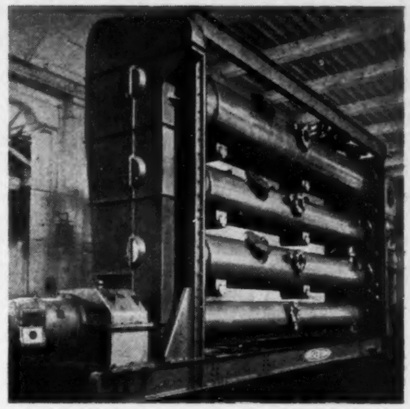


Fig. 5. Drying and cooling tubes for whale livers prior to solvent oil extraction (erected in workshops at Messrs. Rose, Downs & Thompson Ltd.).

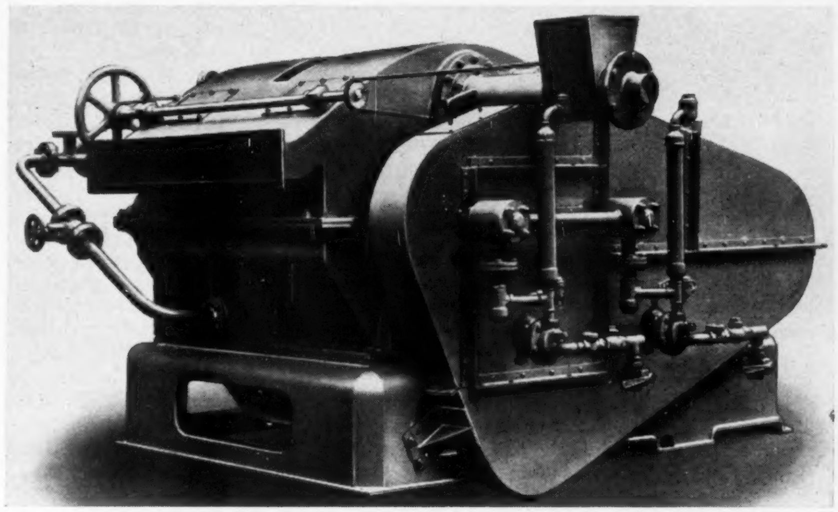


Fig. 4. Coagulating chamber for preliminary treatment of whale livers.

Liver plant

The exceptionally valuable liver oils with a high vitamin A potency are recovered by solvent extraction and the residual solids form a valuable feeding meal with a high riboflavine content. Because whale liver oil is so exceptionally valuable, great care is taken to extract the maximum quantity of oil; to prevent oxidation of the vitamin A content, and to avoid wastage at any point in the process.

The initial preparation consists of reducing the raw liver in mincers, preparing a form of flake, and lowering the moisture content before the oil is extracted. The flaking is carried out in a coagulating chamber (Fig. 4) and the drying and cooling is provided by a horizontal tube unit (Fig. 5).

The oil is extracted from the dried and cooled liver flakes in a batch solvent extraction plant, using trichlorethylene as a solvent which is reclaimed from the resulting mixture of oil and solvent by distillation. Trichlorethylene is used because it

(*Concluded on page* 31)

Fluorescent Tracer Agents

By J. A. Radley, M.Sc.(Lond.), F.R.I.C.

The many analytical uses to which the fluorescence of organic and inorganic compounds irradiated with ultra-violet light can be put, in the chemical and food industries, have tended to overshadow the less spectacular but nevertheless occasionally important uses to which fluorescent compounds and reactions giving fluorescent end-products lend themselves in other directions. Some manufacturers have found these uses to be of great value in assisting them in their marketing arrangements by preventing fraud, detecting sales of substituted products under their label, indicating undesirable customers, and tracing certain faults in the factory. In short, whenever a product is required to be 'tagged' or 'labelled' in an invisible and harmless manner, so that only the maker can identify it, then the 'fluorescence tracer' technique can be applied.

SOME substances show a pronounced fluorescence in an appropriate solvent at dilution as low as 1 in 10^{-7} to 10^{-8}, and it is possible in many cases to work with a very low proportion of the "tracer" in an article, and to concentrate it by suitable, rapid means when testing the product. For concentration of the tracer the use of ion exchange resins, capillary strip analysis, and selective absorption may be used.

Effect of ultra-violet radiation

When ultra-violet radiation falls upon a substance it may be reflected unchanged, or absorbed and converted to heat or to some other form of energy. When the energy change results in the emission of radiation of a different wave-length, the phenomenon is called *luminescence*. If the emission ceases immediately the irradiation is interrupted, the term *fluorescence* is applied. If it continues for an appreciable time after the irradiation ceases, it is known as *phosphorescence*.

Fluorescence, or the emission of radiation during excitation with radiation of a different wavelength, may be in the visible region, when the substance "glows" while it is illuminated, or it may be in the ultra-violet or infra-red region, in which case it is invisible to the eye. Fluorescence is practically always of a wavelength longer than the radiation exciting it, so that, for example, some substances may be irradiated with the very short wavelengths in the X-ray region, and the fluorescence is situated in the ultra-violet region, or in the visible region. Others irradiated with ultra-violet light emit a fluorescence in the visible region, and some substances irradiated by visible light give a fluorescence in the infra-red region.

The only region concerned with this discussion is that between 3,000 and 4,000 A.U. (the near ultra-violet region) as the exciting source, giving fluorescence effects lying in the visible region. Special effects can be obtained using shorter wavelengths to excite substances not so affected by the long wavelength rays. The fluorescence effects obtained vary from substance to substance, the colours shown ranging throughout the visible spectrum and the intensity varying from brilliant to dull. Some substances fluoresce only when dissolved; others only when applied to certain substrates, such as paper; others fluoresce to an appreciable extent only when in the solid state. All this has an important influence on the choice of fluorescent substances for a particular use.

Source of ultra-violet light

The source of ultra-violet light may be any of the arc lamps or quartz discharge tubes on the market for this type of work or for medical work. For fluorescence work, however, an essential component of the lamp system is the dark glass filter which transmits the ultra-violet light from the lamp, but absorbs all the visible light given out, with the exception of a small amount of violet or red light. The lamp is contained in a light-tight lamp housing which has the dark glass filter in a suitable position in one of the walls.

Two very useful and cheap sources of ultra-violet light are small quartz mercury arc lamps enclosed in the bulb of black glass which acts as the filter and allows only ultra-violet radiation to pass. They can be plugged into the ordinary house circuit providing the correct choke is used. The cost of the bulb and choke is only a few pounds.

Some uses of fluorescence

As an example of the use of fluorescence, some years ago a firm disposed of some of their products, which had been rejected on quality grounds in the factory as not fit for human consumption. To their alarm they began to receive complaints from the public. It was not possible to identify which merchant had been guilty of passing on the poor material for human consumption or to find out whether this had been deliberate or accidental, so that on the next occasion rejects were accumulated, only very small parcels were offered, each tagged with a different tracer. One complaint arose after this disposal, and by characterisation of the tracer the merchant responsible was identified, and appropriate action taken.

In some cases, products of the same class on the market are so much alike that it is not easy to distinguish between them except by detailed examination and analysis. One manufacturer regularly incorporates a minute fraction of a fluorescent compound which enables him to identify his product at a glance under the lamp. This technique is capable of almost infinite variations in the tracer used which can be selected for suitability for the product and the purpose required, and has been of value on several occasions in detecting "black market" operations.

Another use for fluorescent tracers has been the application of the usual packer's number and date stamp to packaging material, using colourless materials which fluoresce under ultra-violet light. In some instances, manufacturers have, for one reason or another, preferred to use a colourless, non-fluorescent stamp, which can be made fluorescent on being treated with a reagent.

On occasions, complaints are received from consumers on the quality of a product which the manufacturer suspects, but cannot always prove, may be due to poor storage conditions in the retailer's shop. An invisible stamping on the inside of the carton, which, by its appearance in ultra-violet light, shows whether the carton has been subjected to temperatures or humidities in excess of those desirable for maintenance of good quality of the pack, has been of assistance in such cases.

Check on pilfering

One trouble that arises from time to time in factories is petty pilfering of such solvents as petrol, oil, and methylated spirits. There have been occasions, however, when the trouble has risen to the proportions of wholesale theft. In several such cases the addition of a small amount of a highly fluorescent, innocuous, and colourless compound to the solvent has allowed the quick and certain identification of samples suspected to have been stolen, since their examination under the lamp has revealed the characteristic fluorescence of the added compound. The substance added, besides being innocuous, must also be entirely foreign in nature, and unlikely to be a natural contaminant. This technique was patented before the war, but the patent has now lapsed.

Tracing petrol thieves

When dealing with skilled thieves who may be aware of the possibilities of the fluorescent tracers, a non-fluorescent type may be used which can readily be con-

verted by a simple reaction into a fluorescent compound. A simple illustration of this, but not involving fluorescence, is the colourless tracer added to commercial petrol in the U.K. during the rationing period.

For an ordinary petroleum solvent, such as petrol or benzene, commercial anthracene can be used. A small amount of this tracer is added to the bulk of the solvent, and to test the sample it is spotted on a white filter paper or piece of white cloth and allowed to dry. If the spot is held under the lamp it appears faintly blue while still wet, but as it dries a brilliant greenish yellow fluorescence appears progressively from the circumference and spreads inwards. If it is desired to have the liquid itself fluorescent, quite a number of compounds are available to give this effect. On the other hand, when a colourless non-fluorescent liquid is required a small amount of α-naphthylamine may be added. To detect this addition, the sample is shaken with dilute hydrochloric or sulphuric acid under the lamp, when a brilliant blue fluorescence in the acid layer is obtained. The use to which the solvent is put in the factory governs to a large extent the nature of the added tracer, but the number of substances that can be used allows the selection of one that is suitable in all respects.

Tracers and liquids

Concerning liquids, the tracers employed are generally those which show a visible fluorescence in solution immediately they are irradiated. For example, the course of water can readily be followed by the intense fluorescence imparted to it by Fluorescein LTS. One of a number of pipes may be cracked, thereby causing flooding or seepage, but the site of the leak may be hidden, either underground or under a floor. To uncover all pipes throughout their length might very well prove costly, especially if the damaged pipe happens to be the last to be uncovered.

By pumping a solution of Fluorescein into one pipe at a time, and watching the flood water, the damaged pipe may be readily revealed by the appearance in the seepage of an intense green fluorescence, which is visible in daylight. If the amount of water passing through the pipes is large, the same procedure of pumping in Fluorescein is carried out, but the seepage water is sampled at frequent intervals thereafter, and the samples examined in a long glass cylinder or tube under the lamp. On looking down the tube a greenish fluorescence is seen when the damaged pipe is treated.

The test is so delicate that one part of Fluorescein in 200 million parts of water can be detected in a one-yard tube. Tests like these were applied to the Pluto pipeline during the war to detect leaks which were causing a substantial loss of petrol.

The source of sewage seeping into a pure water supply has also been traced by this method in cases where a factory draws some of its water from wells to supplement that from the mains. The path of neutral or alkaline liquids only can be traced with this substance as it is precipitated in acid waters; with these a basic fluorescent compound should be used, such as β-naphthylamine, and the samples examined in a long tube under the lamp.

Defects in metals

The intense fluorescence of aqueous solutions of Fluorescein and some other substances under the lamp has been used to detect tiny cracks and pinholes in certain sheet materials and to detect flaws in metal containers. For this test the can is sealed with a closure having a tube connected to a vacuum pump, then immersed in a solution of a highly fluorescent compound in water or other suitable mobile liquid and evacuated. Upon breaking the vacuum, opening the container, and examining the inside under ultra-violet light, the appearance of brilliantly fluorescing points and hair lines shows the points of penetration of liquid.

In order to determine whether a batch of material has been properly mixed, it has been found useful to incorporate a small amount of a highly fluorescent product with one of the constituents; the dispersion of this constituent throughout the mix is readily followed by examining samples of the batch under the lamp from time to time.

Standard for pressure gauges

This British standard has been drawn up to deal with the wide variety of pressure gauges that are in general use throughout industry and which may be bought in large quantities under contract or as single units from engineering suppliers. It is hoped that the use of this standard will result in a reduction of the number of types and sizes in use, with consequent benefit to the user in case of replacement and to the manufacturer in the reduction of production difficulties.

The standard deals with indicating pressure gauges, vacuum gauges and combined pressure and vacuum gauges of the Bourdon tube type from 2 in. to 12 in. nominal size and having maximum scale revisions up to 16,000 lb./sq.in. or up to 6 tons/sq.in.

The specification covers test gauges with concentric scales and industrial gauges with both concentric and eccentric scales. There are eight nominal sizes of gauges of the industrial concentric scale type and five with eccentric scales, there being also three sizes of test gauge. The standard covers direct mounting, surface mounting and flush mounting gauges.

The standard pressure gauges have been carefully selected and the maximum working pressures under steady and fluctuating pressure conditions are given in the same table. The standard includes tables specifying a large number of dimensions whose purpose it is to standardise, among other things, the fixing sizes, coupling sizes and dial markings. The graduations are illustrated by charts showing the scales for each pressure range.

Another section of the standard deals with accuracy testing and inspection. There are a number of appendices, of which one deals with testing apparatus and methods, a second deals comprehensively with the installation and use of gauges and a third gives a detailed explanation of the effect that the acceleration due to gravity may have on gauges manufactured and tested in different parts of the world.

Copies of this standard, B.S. 1780 : 1951, may be obtained from the British Standards Institution, Sales Department, 24 Victoria Street, London, S.W.1. Price, 6s. post free.

Whale Factory Ship

(Concluded from page 29)

is non-inflammable, but precautions have to be taken to neutralise the hydrochloric acid which is formed during the reclamation of the solvent. Measures are also taken to reduce solvent losses to a minimum. The solvent free oil is filtered and stored in sealed drums for further processing on land and the extracted meal is dried and cooled, but does not require grinding before weighing and bagging.

In the foregoing systems particular attention has been paid to conveying and elevating methods for the different materials which are handled during the process. This is important since, at certain stages, the materials handled do not lend themselves readily to normal methods of transportation. Full use has been made of the space available, and economies in steam and power; operation and maintenance have been carefully considered by the designers.

Some of the unique designs incorporated in this vessel arose from the fact that as a tanker, she will carry light petrol spirit. This she will undertake at first because the fleet of whale catchers required to enable her to operate as a factory ship is not yet built. Thus, the *Juan Peron* will not undertake her proper duties until next season, but she may also be used as a transport vessel for the products from other vessels in the whaling grounds. This would assist her crew in obtaining experience of the conditions under which they will subsequently be required to work.

Manufacture of 'Pliofilm'

Casting unit of the 'Pliofilm' plant at Wolverhampton.

ALTHOUGH rubber hydrochloride was known as far back as 1805, the year of the Battle of Trafalgar, it was not until 1934 that it became a widely known product under the name *Pliofilm*. It was in that year that it was introduced to the American market. *Pliofilm* is plasticised and stabilised transparent rubber hydrochloride. At first it was used chiefly for articles like raincoats and capes. Then its possibilities as a packaging material were realised and today it is known essentially as a packaging film impervious to humidity and moisture, capable of retaining flavours, and of outstanding durability.

In 1949 the Goodyear Tyre & Rubber Co. opened a new plant for *Pliofilm* manufacture in the U.K. Details of the operation of this plant, which is at Wolverhampton, were given recently by Mr. Charles Lein in a paper before the Institute of Packaging.

To make *Pliofilm*, rubber hydrochloride is cast from a solvent solution to form a transparent homogeneous film. Firstly, however, a specially purified grade of natural rubber is milled.

The result, along with solvent, is delivered to a mixer where it is made up to a cement of approximately 20% solids, which is passed to storage tanks. From the storage tanks the cement is pumped through a measuring tank into a reactor, where it is cooled with refrigerated water. A predetermined amount of dry hydrochloric acid gas is then pumped into the reactor, and the rubber and hydrochloric acid are allowed to age or react. During this period the hydrochloric acid combines with the rubber to give rubber hydrochloride. After reaction, the rubber hydrochloride is transferred to a nickel-clad steel tank, where it is neutralised, heated and compounded before being filtered. Following filtration the cement is passed to storage tanks which are maintained at an elevated temperature to prevent it from solidifying. From this stage it is fed to equipment termed the 'casting unit' for conversion into film. The important components of the casting unit are a spreading knife and a spreading belt. The spreading belt is 165 ft. long and 6 ft. wide; it is an endless *Neoprene* belt, which has been coated in such a manner that it is level all the way across, and adjusted to maintain an exact distance from the knife throughout its length. The knife is adjustable for a variety of gauges. The rubber hydrochloride cement is fed to build a small dam at the back of the knife, and the movement of the spreading belt passing the knife draws the cement under it, and carries the cement into driers where the solvent is evaporated and recovered, leaving the film. At the end of the circuit the film is stripped from the spreading belt, wound on steel shells and transferred to machines where it is re-rolled and slit to widths of 1 in. up to 58 in., in accordance with the requirements of customers. The film is cast to a gauge as low as 0.0008 in., with a tolerance of $\pm 5\%$.

For quality control every batch of film is accurately tested for gauge, taste, moisture vapour transmission, heat sealing and drop height. The drop height is a specification test to confirm the grade or type of film, and is carried out by equipment which allows a 1-in. steel ball to drop from varying heights on to a controlled area of film at a specified temperature. In other words it is a test of impact resistance.

Features of the process

The manufacturing process has some novel features.

All scrap produced by the casting unit and the slitting machines is fully recoverable. In fact, the only loss in the process is the filter press cake, and the solvent is recovered from this.

Solvent recovery is efficient to approximately 97% of the solvent spread, and at the plant in Wolverhampton 30,000 lb. of solvent is recovered each 24 hr. All this solvent is redistilled before being used again to ensure that no taste or odour is imparted to the film.

Heated air moves through the casting unit case at the rate of 22,500 cu.ft./min. This large quantity is required to prevent the accumulation of an explosive mixture of air and solvent. If for any reason the large fan moving this air should stop, an emergency system automatically re-sets valves so that all air exhausted from the case is blown to the atmosphere with two steam ejectors capable of moving 31,000 cu.ft./min.

In case of fire, 900 lb. of carbon dioxide is automatically distributed through the unit and, if this proves insufficient, an additional 500 lb. can be manually introduced. Further, there is a hand-operated water sprinkler system as a last resort.

In the factory at Wolverhampton 100,000 cu.ft./min. of air are introduced into the building. Of this, 60,000 cu. ft. are filtered so that all air in the spreading area, solvent-recovery area and finishing area is clean.

A very thin *Pliofilm* is now available under the name 'tensilised.' By this process it is possible to produce films as thin as 0.0004 in. and even 0.0002 in., the latter yielding 100,000 sq. in. to the lb.

Methane-acetylene process

A new process which uses electrical pulses to convert methane to acetylene has been developed in America, employing radar type or trigger pulses of microsecond duration followed by rest periods 1,000 times the length of the pulse. The use of ionising pulses of square wave is claimed and the process is said to give good yields of hydrogen or acetylene from methane.

An electronic reactor consisting of cylindrical side wall and end closure elements of insulating material carries out the conversion. Two electrodes are secured to the inner faces of the elements and a copper tube is connected to the top electrode to serve as conductor and reactor inlet. An outlet pipe also serves as a connector for the bottom electrode and as a means of discharge. The electrodes are perforated and the reactants passed through the perforations.

Electrical power is supplied to the electrodes through a continuously charged condenser and a striking electrode in the form of an inductance functions to reduce the voltage required to initiate a discharge between the other two electrodes.

Methane is slowly passed through an inlet into the reaction chamber while pulse discharges are occurring between the electrodes, and is converted to hydrogen, acetylene, ethylene, etc., which are drawn off through the outlet. Estimated conversion of methane recycled to extinction is 77% to hydrogen and C_2 fraction and 23% to heavy polymers. Results have shown 50% conversion to hydrogen in a single pass.

The process has been developed by Socony-Vacuum Inc.

Rubber and Allied Products in Chemical Plant Construction

By S. A. Brazier, O.B.E., M.Sc., F.R.I.C.*

Rubber and synthetic elastomers are being increasingly used in chemical plant construction very largely because rubber linings are an economic alternative to special corrosion-resistant metals and alloys which are now scarce. A brief description of the suitability and use of rubbers as linings for chemical plant is given below.

ALTHOUGH rubber components have long been used in chemical plant, the general use of soft rubber or ebonite as a lining or covering for fabricated metal structures seems to have developed in the period of the First World War. This applied particularly to the use of such linings for the transport and storage of hydrochloric acid in bulk, a development which soon showed marked advantage over the use of carboys for this purpose.

Rubber has gained its place in the chemical industry because of its great adaptability. It departs from the normal conception of the requirements of an 'engineering material' and does not obey many of the laws which apply to solids or liquids generally. It is, however, precisely these departures from normal laws which enable rubber to fulfil many of its important industrial applications. A number of its outstanding properties are (1) high chemical resistance now increased by the use of synthetics, (2) good heat resistance, (3) protection against moisture, (4) high resistance to wear and abrasion, (5) high resistance to tearing and cutting, (6) ability to absorb shock and vibration, (7) high electrical resistance and (8) high resilience (*i.e.* low hysterisis). These characteristics can be varied or accentuated by using specialised prescriptions or rubber compounds, for instance at one factory some 4,000 different formulae are on the active list of the mill room where the compounds are mixed and in a normal week's running some 400 may be called into play.

Although most of these formulae are still based on natural rubber, manufacturers have not been slow to take advantage of the specialised properties of synthetic materials like neoprene, butyl, acrylonitrile copolymers, etc., and to use the related elastomers such as polyvinyl chloride, alkathene, silicone rubber, etc.

With the successful use of rubber linings for the storage or transport of basic chemicals came their adaptation and use for agitated reaction vessels with pressure or vacuum operation, pipe lines, valves and pumps, etc. The use of solid ebonite pipes and auxiliary plant items for such processes as the manufacture of vinegar, foodstuffs, and in bleaching and dyeing, etc., had long been established. But the combination of the high chemical resistance of ebonite with the marked resistance of certain classes of soft rubber compounds to the cutting and abrasive action of slurries enables rubber linings or coverings to be considered for the first time in relation to normal fabrication of metal parts, and rubber became a basic structural material for the chemical industry.

*Dunlop Rubber Co. Ltd. Summary of a paper, 'The Field of Rubber and Allied Products in Chemical Engineering,' given before the North-Western Branch of the Institution of Chemical Engineers at Manchester.

Rubber linings

The rubber industry has made marked progress in the type of lining which it can offer to the chemical engineer. Although many failures in the early days can be correctly assigned to inexperience or to the choice of an unsuitable material, more were caused by wrong design of the basic structure. The fact that the coefficient of expansion of ebonite is roughly 5 times that of steel, so that as it is a rigid material, any movement on the part of the metal during plant operation will set up a stress between the ebonite and the metal leading to premature failure, was often neglected. Soft rubber linings are much more tolerant in this respect; it is therefore essential for ebonite or similar linings or covering that a rigid metal structure should be used of sufficient strength to withstand distortion under internally applied pressure.

The metal surfaces to be covered should be smooth, free from porosity, and wherever possible rivets and lap joints should be avoided. Whenever possible all seams and joints in the metal structure should be welded, and finished level with the surrounding surface. Satisfactory lining is greatly facilitated if sharp bends and awkward corners are avoided when designing flanges and inset mouldings in the metal structure. Joints and flanges should be designed to ensure that only minimum pressure is applied to the lining, and all pressures not normal to the support should be eliminated. It is also advisable both for ease of processing and for the safety of the operator to have additional outlets opposite to the point of entry, to allow a direct flow of air through the tank to remove any fumes.

Completely welded vessels are now becoming more popular on the score of cheapness and efficiency and the saving of metal. Access by a single manhole causes some difficulty in getting rid of solvents used in the lining process. Twin manholes or other means of obtaining air circulation should be aimed at in designing such vessels.

For satisfactory lining with rubber, solid drawn pipes are superior to seamed pipes, but where the latter are used they should not be left open but welded, so that no springing action occurs likely to set up strain in the lining. Screwed flanges should be welded flush with the end of the pipe, leaving no threads exposed.

Welded sheet steel constructions are preferable in every way to cast iron or cast steel, but in circumstances where castings have to be used a close grain or texture in the metal is essential.

Concrete storage and process vessels are becoming increasingly common, many of them of very large size. This is a natural consequence of the great increase in the magnitude of heavy chemical plants. Concrete vessels can be rubber lined.

Wooden tanks have been successfully lined with rubber. Hard, medium and soft woods properly seasoned, with low resin, absence of knot-holes and fairly straight grain have been used.

In certain structures, such as pickling vats, it has been found advantageous after lining with rubber to construct a further inner lining of brick or tile. This serves as a protection against abrasion or other mechanical damage, and also increases the temperature gradient between the rubber and liquor.

Use of synthetics

In recent years developments in the application of synthetic elastomers to chemical plant have greatly extended the scope of the rubber manufacturer in this field.

Neoprene. It is often difficult to develop suitable technical properties in natural rubber combined with adequate resistance to traces of oils or solvents. Extensive use has therefore been made of neoprene or polymerised chloroprene since its introduction by the du Pont Company of America in 1929.

Butyl. Butyl rubber was introduced in 1937. It is an interpolymer of isobutylene with a small percentage of isoprene to give controlled unsaturation. It has an extensibility within the same range as that of natural rubber. Resilience and abrasion properties are lower, although tear-resistance and flexibility are equivalent to those of rubber at low temperatures. It is, however, temperature sensitive and resilience

increases with temperature rise. Impermeability to gases is exceptionally high and water absorption is low, being about 2% by weight as compared to 25 to 40% for natural rubber.

For chemical plant work the outstanding feature of butyl is high chemical resistance. It is superior to rubber in handling pickling liquors containing hydrofluoric and nitric acids in low concentrations. It also has good resistance to copper salts, and can be used with certain organic nitro and amino derivatives and solvents such as ethers, alcohols and esters.

PVC. The marked advantages of plasticised polyvinyl chloride linings and coverings for chemical plant under some conditions are now becoming generally recognised, especially for processes involving the use of acids or strong hypochlorites. Nitric, chromic and hydrofluoric acids can be handled at temperatures up to 60°C in concentrations which would have a severe deleterious effect on natural rubber. Tanks for the immersion pickling of stainless steels, in which nitric and hydrofluoric acid mixtures are used at 60°C, have given satisfactory service, and linings have remained essentially unaffected by solutions of chromic acid used in the chromium plating process.

Silicone rubber is an organo-silicone polymer with heat resistance over an unusually wide temperature range. As the compound has no chemical unsaturation it does not respond to the usual sulphur vulcanisation methods of organic rubbers, and while the special 'curing' techniques can give a limited variety of characteristics in the finished material, the modifications which can be obtained by compounding are not so extensive as with other materials used by the rubber manufacturer.

Although at normal temperatures physical properties are not so good as those obtained with natural rubber, they become relatively superior at extreme temperatures. Flexibility and elasticity are retained at temperatures as low as minus 70°F, and are only slightly impaired after 20 hours' exposure at 572°F.

In spite of fairly good oil-resistance, general chemical resistance is not high; considerable swelling is caused by solvents such as benzene, toluene, petrol and carbon tetrachloride, but the original properties are regained as the solvent evaporates.

Work on silicone rubber has hitherto been somewhat restricted by the high price and limited supply of the raw material available, and it is hoped that the recent decision to manufacture in this country will enable an expansion in its development and application to industrial purposes.

Testing of linings

As a measure of protection, rubber linings are now almost universally subjected to a dry spark test after cure to detect pinholes or other paths to the metal. A high frequency low current discharge of the order of 20,000 volts and giving a spark of approximately 1¼ in. long is usually employed.

The operator uses a long flexible wire as a probe, and the whole surface of the lining is searched for signs of weak seams, perforations or other defects likely to reduce the protective life of the lining.

Although this form of test has much to recommend it over the earlier electrolytic test, there are pitfalls to be considered. Soft rubbers and ebonites are extremely good insulators, and resistance of the order of 10^{15} ohm./cm. can be obtained in the compound used for chemical plant work. A lining ⅛ in. thick can therefore have considerable local reduction in thickness whilst still passing the spark test. By careful use, however, a weakness or defect in the lining can be detected by a change in the colour and localisation of the spark when the probe approaches the defective area. It is within the author's experience that fissures or cracks so fine that acid will not penetrate to the metal, even after long periods, can be immediately detected by the intelligent application of this test.

The electrolytic tests used for enamelled equipment are not usually suitable for rubber linings.

Apart from linings, another very attractive field is the use of soft rubber or ebonite for covering the metal basic structure of filter press plates or frames. The chemical resistance and cleanliness of ebonite are ideal for this work, and the resistance to erosion of the soft rubbers is very attractive where gritty slurries have to be treated.

The necessary moulds are, however, extremely expensive, and unless the customer is prepared to bear the cost because of special conditions, or a sufficiently large number of presses can take the same size of plate, the cost may be uneconomic. Considerable progress has been made in the United States in the application of soft rubber and ebonite as protective media for this purpose.

Automatic Process Control

THIS book* may well claim to be the first British text on the modern theory of automatic process control and it fills a conspicuous gap in the literature. It is a survey of the underlying principles applicable over the whole field of automatic control systems and it is not specific to any particular process or apparatus. The treatment throughout is of a generalised variable, but the numerical examples used for illustration are based on typical process control time-constants, and the nomenclature is that defined by the recent British Standard Specification on process control (B.S.S. 1523 : 1949).

The early chapters are devoted to a qualitative survey of the essential problem—the basic control loop, the nature of the response to corrective action and the time delays and lags involved, and a classification of the types of control action mainly used in process applications.

The major part of the book develops the mathematical analysis of the control system, mainly by the method of harmonic analysis. There is a preliminary survey of analogous transfer stages, the resistance-capacity type commonly found in process plants and the mass-spring-damping type found in certain measuring instruments. The response of single and coupled transfer stages to step, linear and sinusoidal forcing functions is investigated, with a full discussion of the damped transient response of the *LRC* system.

The mathematical treatment is then extended to a hypothetical control system comprising a plant of three coupled *RC* stages with the five different types of continuous function control (*viz.* proportional, integral, proportional plus integral, proportional plus derivative, and proportional-integral-derivative). The criteria for the stability of a continuous oscillation of the controlled condition are determined in each case, and the dependence of the degree of damping of the oscillatory response upon the various control factors is examined. The analysis also includes the effects of supply and demand load changes and changes in desired value, the effect of lumped and distributed constants and of distance-velocity lags. The theory is extended to include systems of multiple control, *e.g.* cascade control, and the effects of discontinuities such as over-ranging of the regulating unit.

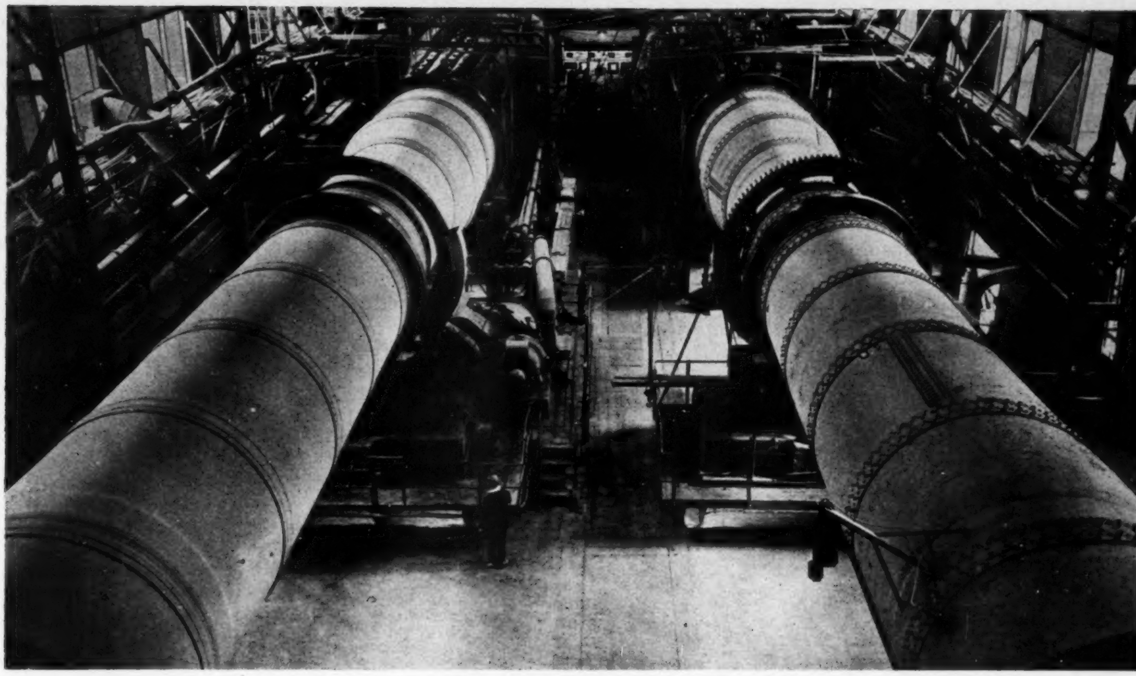
The final chapters are devoted to an analysis of the plant and regulating unit, with an interesting section on the formulation of electrical analogies, and to the controller itself, an analysis being presented of a conventional pneumatic controller. The inherent non-linearities of the proportional response and the interaction of the integral and derivative responses on the proportional band receives some discussion.

The mathematical treatment is necessarily rather advanced; the author provides an excellent summary of the use of complex numbers and the 'p' operator, but it will be necessary to accept some of the statements of the Heaviside expansion theorem. Apart from this, the book should be within the capabilities of the average graduate. The bibliography provided could profitably be extended to include recent papers on the subject.

For those interested in any field of automatic control and particularly process control, this book should be interesting and stimulating. It should also prove of great value as a textbook for any student specialising in this most interesting subject.

A. POLLARD

**The Fundamentals of Automatic Control*, by G. H. Farrington. Chapman & Hall, London, 1951, pp. 285 incl. index, 30s.



Sulphuric acid plant kilns.

Sulphuric Acid and Cement from Anhydrite

ANHYDRITE is one of the few sources of sulphuric acid indigenous to Great Britain. This mineral, chemically calcium sulphate, is found abundantly in many parts of the U.K. Yet only a minor proportion of British sulphuric acid is made from it. In 1950, for instance, only 101,000 tons or 5.6% of the total tonnage of H_2SO_4 were made from anhydrite. However, this was slightly more than in the previous year.

The only plant in the U.K. making acid from anhydrite is the Billingham unit of Imperial Chemical Industries Ltd., which has a capacity of something like 100,000 tons p.a. and which has been working for over 20 years. This is to be enlarged by three-quarters. A much publicised newcomer in the anhydrite-acid field is the United Sulphuric Acid Corporation which is to build a plant on Merseyside to make 150,000 tons H_2SO_4 p.a. When this and the extensions at Billingham come into operation there will be capacity for making 325,000 tons of sulphuric acid p.a. from anhydrite, 18% of present consumption. This will in effect double the total production of acid from indigenous raw materials bringing it to 40%. On present and future sulphur supply prospects, this percentage is still regarded as small.

A paper on the production of sulphuric acid and cement from anhydrite was recently presented by Dr. John Manning, of Imperial Chemical Industries Ltd., at a meeting of the Fertiliser Society in London. A brief summary follows.

Process details

The cement-sulphuric acid process used in the United Kingdom is based essentially on a German process which was tried out on plant scale at Leverkusen in the late 1920s. Difficulties were encountered and the experimental work at Leverkusen was followed by work in this country. In 1929 a cement-sulphuric acid plant was erected at Billingham and production started in 1930. There were initially troubles and during the early 1930's there was some liaison work with the Germans and a little later they started their own plant at Wolfen.

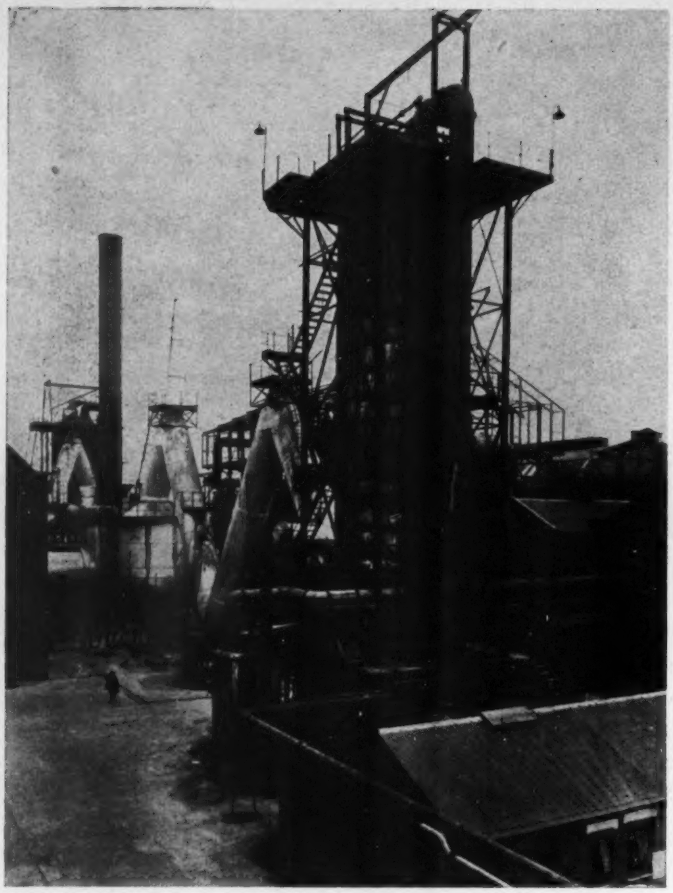
In this process the anhydrite is decomposed to the sulphide by carbon and the reaction of this sulphide with the residual anhydrite is aided by the presence of acidic oxides, alumina and silica, in the correct proportions to form cement. If only the main lines of the process are considered it consists of five stages which are (*a*) preparation of raw materials, (*b*) reactions in a rotary kiln, (*c*) purification of the gases, (*d*) conversion of the sulphur dioxide and gases to sulphuric acid, and (*e*) conversion of the kiln clinker to cement.

Cement manufacture

The raw materials are anhydrite and sources of alumina and silica in suitable proportions. Before mixing, the raw materials are dried and then stored in separate bunkers from which predetermined weights can be taken. After passing through the grinding mills the materials again pass to storage bunkers to ensure the continuous running of the kilns which form the next stage of the plant. These kilns are very similar to an ordinary cement kiln. The first step of the reaction in the kiln is probably the reduction of anhydrite with coke. Then follows the decomposition of the anhydrite by calcium sulphide. Finally, any residual calcium sulphate reacts with the silica which also combines with the lime and alumina present to form a cement clinker. The gas, containing 9% SO_2 together with nitrogen and CO_2 and a little oxygen, passes from the kiln to the sulphuric acid section. The clinker at the opposite end of the kiln, after having gone through the firing zone, falls through recuperators, where it is cooled, and then passes on to the cement works for grinding, packing and export.

Sulphuric acid manufacture

The gas purification is very similar to that adopted in a pyrites sulphuric acid plant. Dust is first removed in cyclones and the gas still containing appreciable proportions of dust is then cooled in wash towers. Further quantities of dust are removed in these towers from which the water is taken and the dissolved SO_2 removed by passing the water countercurrent to a stream of air. The SO_2 containing air joins the main gas stream. The cooled humid gases still containing some dust and mist are treated with electrostatic precipitators and the gases are subsequently dust free and optically clear. The next stage of purification is



(This and block on preceding page are reproduced by courtesy of the Fertiliser Society)

Gas cooling towers.

water removal, which is done by counter-current scrubbing with sulphuric acid.

The gases, after leaving the drying towers have their SO_2 content reduced to about $6\frac{1}{2}\%$. They then pass through blowers and through heat exchangers, by which they are heated to temperatures just over 400°C, and through converters containing platinum or vanadium catalyst. The converted gases are taken to an absorption system where sulphur trioxide is absorbed in 98% sulphuric acid which is diluted by drying tower acid to give an R.O.V. product containing 96% H_2SO_4.

Ion-Exchange Resins

NOBODY who knows their work will deny that Kunin and Myers are masters of their subject. It is unfortunate that they have not been able to present the subject with equal mastery. Their book* is verbose, frequently repetitive and occasionally contradictory, and some of the English is a little strange ; the result is that hard digging is often necessary to expose the real meaning. It is generally possible for the reader to do this, but whether he could do so without previous knowledge of the subject is doubtful.

The book gives the impression of having been written in a hurry, and much of the subject matter is dealt with in a very cursory and superficial manner. This is particularly true of chapters 9 and 10 dealing with the applications of ion exchange, and these resemble in places Dr. Kunin's admirable literature reviews which appear annually in *Industrial and Engineering Chemistry*. This method of presentation does not, however, give much immediate information. Indeed, the book is more a source book of literature references than a work complete in itself.

The chapter on the synthesis of ion-exchange resins is disappointing. An excellent opportunity presents itself for collating the vast amount of work of which the patent literature has been the only source of information. However, the same cursoriness is apparent and the few pages devoted to the topic, apart from electron exchange and selective ion-exchange resins, deal almost entirely with German resins, now obsolete outside Germany. Again, most of the literature references are there, but the information is not ; the position remains that the patents themselves are still the only source of real information on the synthesis of ion-exchange resins.

The theory and mechanism of ion exchange are rather more fully dealt with, although undue stress has been laid on the earlier theories at the expense of the newer. In pointing out the difficulties of determining the correct activities to use in applying the law of mass action to cation-exchange equilibria, the authors suggest that Marshall's measurements of ion activities with clay membranes 'represent a milestone in surmounting one of the last obstacles in ion-exchange equilibria.' Unfortunately, they do nothing of the kind ; these measurements give activities in solution only which, in any case, can be obtained by other methods ; they give no information about those in the solid. This is still the real difficulty.

Other chapters deal with ion-exchange resin characteristics, softening and de-ionisation of water, ion exchange in analytical chemistry, methods of studying the physical and chemical properties of resins, and ion-exchange equipment design.

A feature of the book is the presentation of data, hitherto unpublished, on the *Amberlite* series of resins. This has enabled the authors to present certain aspects of the subject which they might not otherwise have been able to do. Unfortunately, however, the effect is to make the book very one-sided, since resins other than these are scarcely mentioned at all.

Printing errors are comparatively few and only rarely is the correct meaning in doubt. One error, however, which appears to be a real one is in the formulation of Kielland's expression for the activity coefficient in the solid phase : log γ is not proportional to the square of the mole fraction of the same component, but to that of the other.

Essentially the book will be of use to those wishing to gain an introduction to the field of ion-exchange resins ; those looking for a fuller treatment will probably find Nachod's book more profitable.

T. R. E. KRESSMAN, PH.D., D.I.C., A.R.I.C.

**Ion Exchange Resins*, by R. Kunin and R. J. Myers. Chapman & Hall, London, 1951. Pp. 212, including index, 38s.

Nickel chromium alloys. A new publication from Henry Wiggin & Co. Ltd. presents all the available information on the *Nimonic* series of alloys. In addition to tables of physical and mechanical properties, a useful series of graphs gives design data of these nickel-chromium alloys at various temperatures ; in this section appear some data only recently determined as a result of the long-time creep testing which is still in progress. Other sections summarise the heat-treatment and acceptance creep tests laid down in the appropriate D.T.D. specifications. A list of typical applications shows that these nickel-chromium alloys, in addition to their use as the standard creep-resisting material for turbine blades in British aircraft gas turbines, have a wide field of application for many other components operating at elevated temperatures.

Iodine as a Catalyst

IODINE and its compounds are used as catalysts in many types of industrial chemical processes. Halogenation, condensation, alkylation, hydrogenation and sulphuration are the principal examples and indicate the wide scope and tremendous practical importance of catalytic chemistry. Although it is well known that iodine is a valuable catalyst for many types of chemical reactions, scientific and technical literature dealing with the behaviour of iodine and its existing compounds as catalytic agents has not been correlated. Now the Chilean Iodine Educational Bureau has published *Iodine Information No.* 32, which contains a summary of the most important uses of iodine in catalysis together with a bibliography of published information containing 266 references, an index of processes and operations in which iodine and its compounds are employed as catalysts, and a list of the patents included in the bibliography.

Halogenation

The use of iodine as a 'halogen-carrier' is well known and the element is widely used as a catalyst for directly chlorinating and brominating organic compounds. The process of direct iodination is more difficult to accomplish and iodo-compounds are usually prepared indirectly.

Iodine is an effective catalytic agent for the chlorination of hydrocarbons and their derivatives. The most successful results with benzene, toluene, xylenes and naphthalene are obtained by chlorinating these compounds in the vapour phase using 0.5 to 1% of iodine as catalyst.

The effect of iodine on chlorination processes can frequently be enhanced by the presence of iron. Iodine and iron together form a most powerful catalyser and the presence of 0.1% of iodine plus 1% of iron induces rapid chlorination at low temperatures of compounds that otherwise react slowly with chlorine even at high temperatures. Thus, *para*-chloronitrobenzene, *ortho*- and *para*-nitrotoluene nitrobenzene and paraffin are chlorinated at 40 to 50°C. with considerable heating effect, necessitating external cooling. Ferric iodide has been employed with considerable success as a catalyst for the chlorination of benzene derivatives and the preparation of aralkyl halides from ethers by treatment with hydrogen halides. An interesting example is the synthesis of benzyl chloride from dibenzyl ether.

Iodine is frequently used for the bromination of organic compounds and is especially effective when it is desired to brominate the aromatic nucleus. When a mild brominating agent is required a condition favourable to the formation of iodine monobromide (*i.e.* the presence of an excess of iodine) should be maintained. By this method such reactions as the conversion of *alpha*-naphthol to 4.bromo-*alpha*-naphthol with 63% yield and of naphthalene to *alpha*-bromonaphthalene with 55% yield can be achieved.

The direct introduction of iodine into hydrocarbon molecules is difficult, but is occasionally possible with the aid of ferric chloride as catalyst. The yields, however, are very low and indirect reactions are invariably used for the production of iodo-compounds. In such reactions it is often found that the presence of potassium iodide increases the rate of reaction and the yield.

At this point it is convenient to mention that organic chlorine derivatives usually react with less facility than the corresponding iodine compounds. Their reactions can, however, frequently be greatly assisted by the addition of potassium iodide, which apparently permits the progressive transformation of the chlorides into the more reactive iodides.

Condensation

Iodine is extremely efficacious as a catalyst in condensation reactions of aromatic amines involving the elimination of ammonia or water. Such reactions are quite generally employed for the production of secondary amines, with good yields, from the three toluidines, *ortho*- and *para*-anisidines, *meta*- and *para*-chloranilines and the naphthylamines by condensation with other aromatic amines, naphthols and phenols. Thus either *alpha*-naphthylamine or *alpha*-naphthol heated with aniline in the presence of less than 1% of iodine is converted to phenylnaphthylamine, the yield being about 85% of the theoretical.

Traces of cuprous iodide can readily effect the condensation of primary aromatic amines with phenyl bromide, with elimination of hydrobromic acid. The acetyl derivative of the amine may be used. Thus by heating a mixture of bromobenzene, acetanilide, sodium carbonate and cuprous iodide for several hours, acetyl-diphenylamine is obtained and this can readily be transformed into diphenylamine. The cuprous iodide can be replaced by copper and iodine or even by copper and potassium iodide.

Further examples of the catalytic properties of iodine in this field are the quantitative formation of *beta-beta*-dinaphthylamine by heating *beta*-naphthylamine at 100°C. with 0.5% of iodine and the conversion of *para*-aminophenol to dihydroxy-diphenylamine in the presence of 0.0025% of iodine.

Alkylation

Primary aromatic amines can be alkylated by direct reaction with alcohols in the presence of iodine as a catalyst. The method is especially suitable for the alkylation of aniline and *alpha*-naphthylamine.

A technical process for the production of dimethylaniline consists in heating a mixture of aniline, methanol and iodine at 230°C. under pressure. Small amounts of aniline and methylaniline present in the crude product are removed by adding acetic anhydride to react with these impurities. The unattacked tertiary amine is then separated from the less volatile acetyl derivatives by distillation.

Methyl aniline is prepared by a similar method at a temperature of 180°C. and mono- and di-ethylanilines can be produced in an analogous manner by the use of ethanol.

Sulphuration and sulphonation

The use of iodine as a catalyst permits the direct sulphuration of many aromatic compounds. Outstanding and important examples are the preparation of thiodiphenylamine (phenothiazine) and thiodinaphthylamine by fusing the corresponding amines with sulphur in the presence of iodine.

Iodine acts also as a catalyst for the sulphonation of aromatic compounds by the action of sulphuric acid and the reaction proceeds smoothly when hydroxy, bromo, chloro, amino, or carboxy groups are present in the molecule. If nitro or sulphonic groups are present the reaction will prove difficult or impossible.

The presence of iodine affects the course of the sulphonation of many compounds, notably that of benzoic acid, which is sulphonated to *ortho*-sulphobenzoic acid under the influence of iodine. When iodine is absent the *meta*- and *para*-acids are formed. Toluene, chlorobenzene and bromo-benzene are sulphonated only in the *para* position when iodine is employed.

The use of iodine is also advantageous when it is desired to prepare sulphonyl chloride derivatives and sulphonates by the use of sulphuryl chloride. The procedure recommended is the addition of small quantities of iodine to a cooled mixture of sulphuryl chloride and an aromatic compound. In addition to the sulphonyl chloride derivatives, relatively small amounts of chlorinated hydrocarbons are formed.

Synthesis of organic acids

In the presence of catalysts prepared by absorbing volatile iodides on active charcoal, aliphatic acids are synthesised from steam, carbon monoxide and olefinic hydrocarbons. Hydrogen iodide and ammonium iodide are the compounds generally employed for the preparation of the catalysts and the process is carried out at a temperature of 325°C. and under very high pressure. For the synthesis of propionic acid a mixture of 25 parts water vapour, 72 parts of carbon monoxide and 3 parts ethylene is employed. Butyric and valeric acids are produced in similar ways by substituting propylene and butylene respectively for the ethylene.

Air Pollution Problems

THE contamination of the atmosphere is due to many causes, and impurities discharged from process industries have included smokes from fuel-burning furnaces; dusts from such processes as cement, lime, mineral wood, iron and steel production, rock crushers and others; gases from chemical plants, paint factories, smelting plants and the like; and odours from packing plants, chocolate factories, bakeries and similar sources. Some of the air pollution problems facing the process industries are discussed by Prof. A. G. Christie, the John Hopkins University, U.S.A., in *Mechanical Engineering*.

The majority of process plants have some type of fuel-burning equipment. Any smoke or fly ash from chimneys of these plants are visible contributors to air pollution. Available coal is increasing in ash content, so that fly-ash discharges will increase if preventive measures are not taken. Many industrial centres have laws controlling the discharge of smoke and fly ash. The central stations of public utilities have large chimneys through which the flue gases from large quantities of coal are discharged. Though the amount of smoke and dust per cubic foot of these gases may be small, the large mass issuing from the chimney top causes a diffusion of light and a dark appearance. The electrical utilities have led in the installation of smoke-prevention equipment and dust catchers. No new central station is designed now without such devices. The use of washed coal has been advocated as a means for reducing air pollution, as its ash content is lessened by washing.

Cyclone separators

General practice in central stations is to install cyclone separators to catch the fly ash from boilers with underfeed or travelling-grate stokers. Mechanical or electrostatic separators are used in spreader-stoker or pulverised-coal-fired stations. The fine dust that adheres to the grounded elements of the electrostatic precipitator is often caught up by the flue gases on rapping, and the resultant instantaneous chimney discharge may exceed allowable dust limits. This emission may be lessened by continuous vibration of the grounded elements and by low gas velocities through the electrostatic precipitator. But there is seldom room for such a large electrostatic installation in the width of a boiler space. In some plants double-deck electrostatic units have been proposed to get low velocities. Another plan is to place the cyclone or other device beyond the electrostatic to catch a large portion of the residual dust from rapping.

It has been suggested that washing the flue gases would remove the smoke, fly ash and objectionable gases. This has given rise to other problems. The wash water of such a process becomes acid, attacks any steel with which it comes in contact and cannot be discharged into the river or bay. Neutralisation by alkalis proves expensive. To wash gases throughly and dispose of resultant wastes from water treatment would cost about $2 per ton of coal burned, based on British experiences. In winter months the cold water cools the gases to such a low temperature that the gases leaving the stack fail to rise. If temperature inversion also prevails, these gases fall to ground level and, due to their high humidity and high carbon dioxide content, soon constitute a nuisance to the neighbourhood as well as to the boiler plant itself.

Many industrial plants have boilers with small, old, poorly designed and often indifferently operated hand-fired furnaces. These old plants, often only used during the heating season, cannot be economically equipped with dust-catching devices. In some cases the installation of mechanical stokers with coal- and ash-handling machinery may lessen smoke production and prove profitable in view of increasing labour shortages and high wages.

Boilers in service 25 years or more are less efficient than those now available. They generally lack such heat-recovery equipment as economisers and air heaters. Smoke emission may be reduced and large fuel savings secured by the installation of modern boiler plant.

There is a tendency to retain old chimneys when replacing boiler plant. Sometimes suitable, they are often too low or improperly designed to give adequate dispersion of gases. Dispersion is best secured by using a high chimney. Where induced-draft fans are used, American practice is to increase the gas velocity at the chimney top from the old value of 20 to 30 ft./sec. to as high as 120 ft./sec. at full chimney capacity. In a 10-m.p.h. wind these higher velocities lift the smoke plume to a height in feet above the chimney top equal to the velocity in feet per second.

Process dusts can in many instances be recovered by available equipment. Such dusts may have economic value, for instance iron ore dust from blast furnaces, cement-mill dusts, lead and zinc oxides. Suitable equipment has not been developed to catch certain industrial dusts from very hot gases such as those from brass or iron cupolas and Bessemer and other converters.

Gases and odours

Gases, vapours and odours from process plants contribute to air pollution. Certain odours are not in themselves offensive, yet even the persistent odour of a food-processing factory may become obnoxious if prevalent all of the time. Certain gases and vapours from process industries are objectionable because of their destructive action on vegetation or their corrosive character. Much has been done in the metallurgical industries to lessen the discharge of such gases. Chemical industries are frequently faced with the problem of gas or vapour emissions of an obnoxious nature. There is no method known at present in many cases by which these discharges may be recovered at any reasonable cost or which would yield a return on the operation. It is in the interest of all process industries that concerns which are coping with problems of gaseous discharges should give full publicity to their experiences, so that other managers may attack their problems of air pollution with more factual data.

Los Angeles investigations show that the catalytic effect of sunlight on certain gases, the combination of gases in the atmosphere and the peculiarities of aerosols all require much further study to determine their properties and effects. Many process industries use chemicals and solvents from which certain gases and vapours escape through chimneys or vents into the atmosphere. These may be caught in cooling, washing or absorption processes and may possess commercial value. In other cases, their recovery may prove expensive yet necessary. Noxious or offensive gases from process plants may not be readily removed from vents and much work remains to be done to stop such discharges. Odours from process plants may be offensive and constitute a nuisance. Some are difficult to prevent.

Both ordinance administrators and plant operators are handicapped by the lack of simple standards to measure air pollutants. The Ringelmann chart used for smoke measurement has many faults and is little good on dust or gaseous discharges. Visibility alone is an uncertain standard. The American Society of Mechanical Engineers' code on smoke measurement involves a lengthy test. Meters based on light intensity through a gas column have merit for smoke or dust measurement. At present there are no standards for gases and odours and no simple means of measuring their amounts.

Aromatic solvents for paints. Aromatic hydrocarbons are, in general, much more powerful solvents for resins than either paraffins or naphthenes of the same boiling range. The 15-9 range of aromatic solvents manufactured by Petrochemicals Ltd. is described in a new brochure. The range provides products of constant and specified aromatic contents and accompanying high solvent powers.

Extraction pumps. Rotary air and water extraction pumps are all described fully in a new brochure which gives the principles of operation, ratings, dimensions, specifications and illustrations. The brochure is obtainable from Drysdale & Co. Ltd., makers of the pumps.

New Plant and Equipment

Rigid hammer crushers

Of simple design and rugged construction, the B.J-D rigid hammer crusher is made especially for the reduction of materials such as bark, bones, cattle guts, chemicals, coal, cork, glass, lime, myrabolams, resin and sulphur to small sizes in one operation with a minimum of fines. A leaflet published by the manufacturers, British Jeffrey-Diamond Ltd., describes this crusher. It is a relatively slow machine and is available in a range of seven sizes for various installations and duties. The smallest machine, 15 in. × 8 in., will handle 2 to 3 tons/hr. of coal, while the 42 in. × 48 in. size crushes up to 250 tons/hr.

The specification of these machines is as follows :

Frames. A bolted assembly of heavy cast iron and steel with renewable chrome-alloy white-iron liners. With the exception of the 15 in. × 8 in., the breaker plate on all machines is adjustable and is provided with a shear-pin safety device or shock-absorbing springs. A metal trap with large hinged cover is built into the rear frame on the larger sizes and is optional on small machines, excepting the 15 in. × 8 in. Carbon steel screen bars can be fitted to the base and spaced to suit the material to be dealt with and the product required.

Rotor. A large diameter shaft carries steels discs. The end discs are flanged to form a seal with the side frames. Each hammer is reversible and has six working faces.

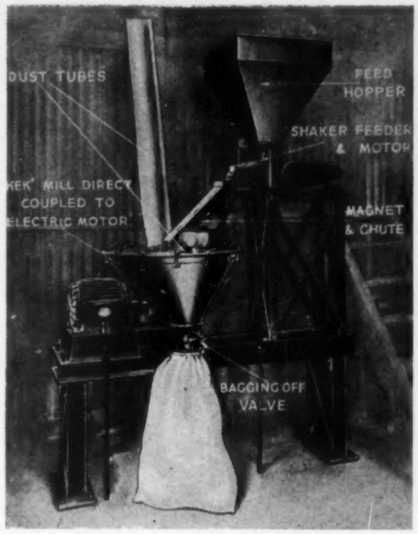
All machines with the exception of the 15 in. × 8 in. are fitted with a shear-pin device in the driving pulley. On the 15-in., 20-in. and 24-in. size crushers, the flywheel pulley is arranged for flat belt or 'V' rope drive. The 36-in. and 42-in. crushers are supplied with 'V' rope pulley only.

A subsidiary drive can be taken from the rotor shaft extension on the opposite side to the driving pulley. This extension is provided as a standard feature on all except the 42-in. machines.

Bearings. Ring-oiled bearings with renewable bushes, or ball or roller bearings carry the rotor. When required, an outboard bearing of similar design is provided at the pulley side on the larger crushers. The outboard bearing housing is mounted on a cast-iron support frame arranged to suit conditions on site.

Power filer

A power-operated hand filing machine has been developed by Brooks & Walker Ltd. for use in the manufacture of punches, dies, moulds and all precision tooling. Weighing less than 1 lb. and conveniently held in one hand, this reciprocating unit is claimed to combine speed and high accuracy. Diamond-impregnated and carbide cutting tools are also available for working hardened steels, minerals, glass and ceramics. A workshop unit available from the same company is a flexible-shaft machine suitable for fine engineering work. It comprises a high-speed universal motor, stainless-steel flexible shaft and six-speed foot control.



[*Photo: Kek Ltd.*

Component parts of high-speed mill.

High-speed mill

A new mill for grinding, blending and emulsifying has been introduced by Kek Ltd. Fundamentally the mill works on the principle of horizontal high-speed centrifugal action. The grinding mechanism consists of two heavily built circular discs studded with strong metal pins set in concentric circles, openly spaced near the centre but gradually closing towards the periphery. The lower plate revolves at high speed with pins pointing upwards. The upper plate is stationary with pins pointing downwards and fitting into the spaces between the circles of pins on the lower plate. The material to be ground is fed through a hole in the centre of the upper plate. The material is then flung by the velocity of the rapidly turning lower plate against the pins until ground to the required fineness, when it is passed through the last row of pins into the collecting hopper.

One of the advantages of the mill is that there are no screens to clog up. Having passed only once through the mill the material is ground to the required fineness. Another advantage of the Kek system is the fanning action of the rapidly revolving plates, which keeps the substance cool and eliminates any risk of clogging. Vibration in the mill, it is claimed, has been reduced so much that there is no longer the need for heavy foundations.

The mill is being regularly used for treating sugar, face powders, soap powders, lake colours, azo colours, phosphates, moulding powders, stearates, sulpha drugs, gum arabic, tragacanth, karaya, insecticides, cellulose acetate, boric acid, casein, fuller's earth, magnesites, milk sugar, resins salt, shellac, starch, talc, plaster of paris, carbon black, kaolin, titanium dioxide, zinc oxide, whiting and corvic. Another task performed by the mills is the breaking up of seal blubber for the extraction of the oil. This is unique in that it is entirely a cold process.

Rust-proofing plant

A firm making bag-making, -wrapping and -printing machinery at one time had more than 50% of their total exports arriving in a poor condition. To overcome this problem and also that of deterioration of equipment during storage, the firm installed a Jenolite black finish and metal pre-treatment plant. By a single operation of dipping machine parts three functions are performed : removal of rust, prevention of further rust and the creation of a paint bond. In this particular firm's factory, the rust-proofing plant is situated between machining and storage prior to assembly. Thus, rusting of components during storage is no longer encountered, while the greasing and grease removal—paint bond and surface protection—departments are eliminated altogether. The rust-proofing process includes two dip tanks and a third tank for black finishing functional parts after rust-proofing. After the blackening process, components are dipped in a dewatering oil and allowed to drain before storage.

Acid-recovery plant

As a rough estimate about 20,000 tons of sulphuric acid are thrown away in the steel industry each year. A leaflet published by Kestner Evaporator & Engineering Co. Ltd. gives concise information about the Kestner-Fakler acid recovery plant for use in steel pickling works. Some of the advantages of this type of plant are claimed to be (*a*) operable by unskilled labour, (*b*) requires little maintenance, (*c*) construction is in *Keebush* material which is inert to the acid of sulphuric acid and pickling liquor, (*d*) avoids over or under pickling, (*e*) recovers all acid which is normally thrown away, and (*f*) avoids difficult disposal problems.

The operating cycle of the Kestner-Fakler process is as follows :

Spent acid from the pickling tanks is pumped or run by gravity to the storage or settling tank, where it is left for some time to allow the heavier insoluble scale and other solids to settle. The liquor is then drawn off by pump and passed to the crystallisers. Here, ferrous sulphate cry-

stals are formed by direct cooling with slow stirring, the operation being so designed that a uniform crystal size is obtained. If further cooling than that obtainable by ordinary cooling water is required, brine circulation from the refrigerated brine tank is started and the temperature reduced as required.

The mixture of crystals and liquor is then fed by gravity either to a simple filter or to a hydro-extractor, depending upon the size of the plant. The crystals are dropped into trucks or into storage and the clean acid runs into the final storage tank, where it is re-heated, usually by direct steam injection, and then returned to the pickling tank for further use.

Apart from the saving of acid, which will be equivalent to the amount at present sent to the drain, there are other economic advantages to be gained from an acid recovery plant. The copperas which is recovered from the crystallisation process has a definite market value and the demand for it is steadily increasing.

In addition, if neutralisation of spent acid is practised, it is necessary to offset against recovery costs the cost of neutralisation and disposal of the precipitate which may, in itself, involve a substantial outlay in equipment, plus cost of the lime or soda ash used.

Device for checking air pollution

A highly sensitive machine for detecting atmospheric contaminants of any kind, from industrial fumes to poison gases, was recently described to the American Chemical Society. The new machine can measure odours and gases in concentrations of less than 0.01 p.p.m. of air, according to a report by Dr. Amos Turk and Henry Sleik, W. B. Connor Engineering Corp. The need for such a device stems from the fact that only a minute amount of a material can contaminate a wide area.

The problem of measuring the actual concentration of such odorous materials is important, the report explained, because it applies to many cases of odour nuisances of industrial origin, such as gaseous sulphur compounds, nitrogenous pollutants from animal putrefaction, irritants produced from oil oxidation and decomposition, odorous organic and inorganic acids and solvent vapours, and to measurements of toxic gases such as the war gases.

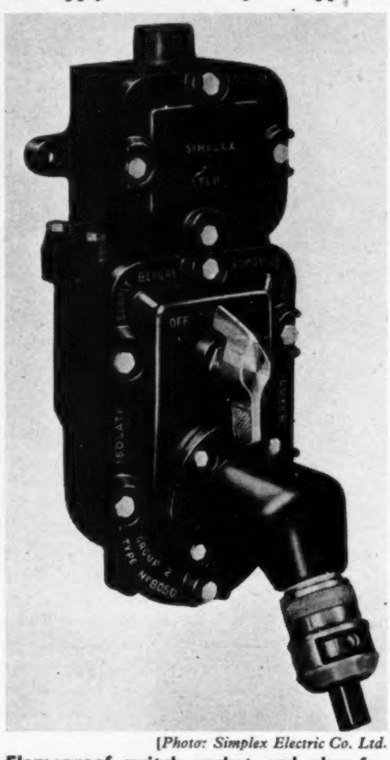
For many odours, no lifeless device is as sensitive as is the human nose. To overcome this difficulty, the new machine was designed with a motor-driven blower which collects large volumes of contaminated air very rapidly, removing the contaminants by the same method that is employed in gas masks. The use of large, measured volumes of air brings the quantities of the impurities in the air up to a size that can be measured by chemical analysis or by spectrometric methods. As in a gas mask, the air is drawn through a layer of powdered carbon, which absorbs the impurities and lets the air and water vapour pass on through. The machine's blower draws 40 cu.ft./min. of air through carbon-filled canisters, and the time of operation in the contaminated air is measured, so that the total volume of air can be calculated. The polluting materials, which remain absorbed in the carbon powder, can be removed by blowing the canisters with superheated steam or by putting them in a high vacuum and then condensing the contaminating vapours with dry ice and liquid air. After the polluting materials have been collected and analysed, the degree of contamination of the air by each impurity can be shown.

For further information on new plant and equipment, please complete the coupon on page 46.

A unique use for this machine involves radioactive tracers. To find out whether a given type of contamination is coming from a certain remote industrial plant, a radioactive tracer can be introduced into that plant's smoke stack. The machine can then be operated at the point where contamination is occurring and, if the materials picked up by the carbon powder become radioactive, as indicated by a Geiger counter, then it can be concluded that they are coming from the plant in question.

Flameproof switch socket

A flameproof switch socket and plug for a.c. supply units for 250-V apparatus supplied by means of heavy T.R.S. trailing cables is offered by Simplex Electric Co. Ltd. Maintenance is reduced to a minimum by simple wiring. The plug portion has provision for the use of screened cables and there is a special clamp to prevent the cable from being pulled out of the plug which is fully interlocked. Full flameproof protection of the pins and sockets during withdrawal is also provided until the circuit is broken. The switch is operated by a self-indicating handle which operates with the plug as part of the interlocking system, and the sealing chamber is supplied complete with a synthetic resin paper compound retaining plate. The pouring spout gives complete filling and has a 1-in. aperture which ensures easy sealing and avoids risk of trapping. The terminal box contains two shell-clamp-type terminals which do not slacken easily and are stable in use, even under considerable vibration.



[*Photo: Simplex Electric Co. Ltd.*

Flameproof switch socket and plug for 250-V a.c. supply units.

Self-lubricated bearings

A new line of graphited oil-less bronze bearings and bushings have recently been introduced by Bronze Bearings Inc., U.S.A., which are claimed to possess the following advantages: no lubrication is required during the life of the bearing; only pure graphite is used with a specially developed and tenacious binder; the graphite composition is applied under pressure by hydraulic or other adequate means, then baked at high temperatures for permanence; and they are impregnated in such a manner as to secure complete surface coverage, giving the working effect of metal saturated with lubricant.

These bearings are claimed to be widely adaptable and can be made in almost any size, and can be installed in inaccessible locations where fluid lubricants would contaminate the work in process, where temperatures would oxidise oil, where oil films would rupture under many static loads, where bearings are immersed in liquid or where machines must be made as immune to neglect and error as possible.

Fans for corrosive gases

While the need for centrifugal fans is undiminished, a demand has grown up for a fan that is capable of handling large volumes of gas at relatively low pressure, for example in draughting fumes emanating from open reaction vessels, metal pickling plants, electrolytic cells, dyeing machines, leaching vats, etc. To meet the demand for an efficient fan capable of handling highly corrosive gases with absolute reliability, a new design of axial flow fan was introduced in 1940 by Kestner Evaporator & Engineering Co. Ltd. Since then the range of these fans has been extended and detail design improved as constant research has thrown new light on aerodynamic problems. A leaflet recently issued by Kestner describes the characteristics of these axial flow fans and gives technical details.

World News

GREAT BRITAIN

Fertilisers and sulphuric acid: new developments reviewed by Fisons' chairman

The effects upon his company's fertiliser production of the shortage of brimstone sulphur, and their efforts to develop alternative sources of sulphuric acid, particularly anhydrite, were reviewed by Mr. F. G. C. Fison, chairman of Fisons Ltd., at the annual meeting of the company held in Ipswich last month.

Discussing first the present conditions in the fertiliser industry, he said that many technical improvements had been made by the company during the year which have effected economies in operation, packaging and distribution, as well as improving the condition of the products. Recent developments include the erection of new sulphuric acid and fertiliser plants at Immingham which are, however, operating at only two-thirds capacity owing to the sulphur shortage. Furthermore, sulphuric acid being produced at the company's Avonmouth factory is being diverted mainly to the steel industry. The result is that considerable quantities of fertilisers which could be manufactured in the U.K. are having to be imported from the Continent.

In the raw materials field, Fisons are taking a leading part in the formation of the United Sulphuric Acid Corpn., of which Mr. Fison is chairman. As the anhydrite-cement plant at Widnes will not come into operation before 1954 and as the establishment of plants operating by this process are not necessarily economic propositions, an extensive programme of exploration for new sulphur deposits and sulphur-bearing ores is being undertaken by the company through the Sulphur Exploration Syndicate formed in conjunction with other sulphur consumers. Although new discoveries have recently been announced in U.S.A., it is not likely that these will lead to an early improvement in the supply position. Moreover, the Government are unlikely to allocate larger supplies to the Immingham plant. Exploration work, therefore, is being pursued as fast as possible. Apart from acid, the raw materials supply on the fertiliser side has generally been satisfactory.

Exploratory drilling for potash in N.E. Yorkshire has continued with satisfactory results and the indications are that a considerably wider field can be worked for potash than had previously been thought possible.

Research is at present being carried out in a number of different directions, notably with the object of substituting nitric acid for sulphuric acid in the solubilisation of phosphate rock. Technical developments adopted by the company include the production of granular fertilisers, the use of paper bags instead of hessian, and the production of triple superphosphate at the new Immingham plant, the first to produce this material in the U.K.

Associated companies in S. Africa, S. Rhodesia and Canada have all had satisfactory years and in every case have yielded increased profits. In S. Rhodesia, a new fertiliser factory was opened in April of last year.

The consolidated trading profits, after providing for the ordinary expenses of the business, had risen from £1,233,724 to £1,901,631. Included in these figures are the trading profits of the British Chemicals & Biologicals Group, which amounted to £221,071, compared with £93,858 in the previous year. Fertiliser sales increased in the U.K., although the overall consumption of fertilisers in the country was not as large as in the previous year owing to poor harvest conditions in many areas in 1950 and the exceptionally wet spring in 1951.

Steel rationing

Control of the distribution of alloy and non-alloy (carbon) steel begins on February 4. The new arrangements will be similar to those in operation up to May 1950, and no person may (from February 4)—with certain exemptions under a small quantities exemption clause—acquire or use specified types of steel unless authorised.

The authorisation will permit the consumer to acquire steel direct or to allow his sub-contractors to purchase steel. Any consumer (except a sub-contractor) requiring steel in the controlled forms who has not already stated his requirements to the appropriate department or to a regional office of the Ministry of Supply, should apply at once to the department which it normally approaches on matters of production. Small consumers—consumers whose requirements are 25 tons or less a quarter including not more than 10 tons of sheets—should apply to their Ministry of Supply Regional Controller. In cases of doubt, application should be made to the Ministry of Supply, Iron and Steel Division, Shell Mex House, Strand, W.C.2.

Present arrangements for allocating sheet steel and tinplate, terneplate and blackplate—which are already subject to distribution control—will remain unaltered. The new order covers alloy as well as non-alloy steel, but consumers will receive separate authorisations for each type and also for sheet and tinplate. Iron and steel stockholders will again need licences to acquire controlled types of steel for re-sale. Existing stockholders should have submitted details of their 1950 trading in non-alloy steel to the Iron and Steel Division (I.S.I. (a)) S.W. Wing, Bush House, Strand, W.C.2. Stockholders who have not already done so and all those dealing in alloy steel should write to this address giving details of their receipt into and sales from stock in 1950.

The Ministry of Supply emphasises that it will, subject to the small quantity exemption provision, be illegal (*a*) for any firm or person to acquire or use controlled forms of steel unless an appropriate authorisation is held, and (*b*) to dispose of such steel except to holders of authorisations.

Copies of the order, the Iron and Steel Distribution Order, 1951 (S.I. 1951, No. 2006), may be obtained from H.M. Stationery Office, London.

Coal and steel production

Last year total industrial production in the U.K. increased at an annual rate of 4½%, half the rate of previous years. The main cause of this lower rate has been the shortage of steel and of some imported raw materials.

Total output of coal in the first 43 weeks was 4,700,000 tons greater than a year before, but during the same time inland consumption was over 6,000,000 tons up on a year earlier. Manpower fell from April to October, but later remained steady. Total stocks are 16,800,000 tons, nearly 1,500,000 tons up on last year, but stocks of household coal are very low.

In the first nine months of last year, crude steel production was 3% below 1950. Shortage of materials, particularly imported scrap, was the reason for the decline.

New distillation unit for oil refinery

Early last year, the chairman of Manchester Oil Refinery Ltd., Mr. H. Stuart Ebben, announced that the throughput of the refinery (which in 1950-51 had reached a figure of 115,000 tons p.a., compared with the war-time figure of approximately 70,000 tons fixed by the now defunct Petroleum Board) would be increased to 150,000 tons p.a. Details of the first step in this programme are now available; they reveal that construction work is already going ahead on a new 3,500 bbl./day atmospheric distillation unit.

The new unit, which will work in conjunction with the existing vacuum distillation unit, will consist mainly of a fractionating tower approximately 120 ft. high. It will extend the existing range of M.O.R. products by producing white spirit and other petroleum solvents as well as petrol. It will enable the refinery to use crude oil from the Middle East as well as from present sources in North and South America.

Gas turbine technology

All chemical engineers interested in gas turbines will be interested to know that the School of Gas Turbine Technology run by Power Jets Ltd., at Farnborough, offers various post-graduate courses on the subject. They include the running and testing of engines, together with performance calculations and specialist lectures on process plant installations and economics.

Q. & Q. director's tour

Mr. Brian H. Turpin, technical and sales director of Quickfit & Quartz Ltd., manufacturers of industrial and laboratory chemical glassware, and a member of the *Triplex* group of companies, recently visited France and the Low Countries. Mr. Turpin spent a week in Holland, a week in Belgium and a short time in the Paris area, during which he attended the chemistry and industry congress and visited the exhibition of laboratory and scientific equipment.

Natural rubber supplies

Asked in Parliament whether, in view of the efforts of the Communists in Malaya to curtail the output of raw rubber in that country, he would consider setting up a synthetic rubber plant in this country, the Secretary for Overseas Trade replied that, while fully appreciating the great importance of protecting rubber estates and all those who worked on them against Communist attacks, he did not think there was reason to fear that the required supplies of natural rubber would not be available for manufacturers in this country.

Sulphur Exploration Syndicate

The Sulphur Exploration Syndicate formed by the leading chemical manufacturers to explore new sources of sulphur, has appointed as chief executive, Major-General G. E. Wildman-Lushington. He will be operating from offices in Ivy House, Newgate Street, London, E.C.1.

SWEDEN

New mining plans

Total estimated costs for putting into operation the state-owned Boliden Ore Co.'s new mine at Rudtjebaeck, will amount to 18,200,000 crowns. The proposed yearly output is 200,000 tons of ore and the costs will be divided over five 12-month periods.

The company hopes to start operations at half-capacity in January, 1955, and full production in July, 1957. An investment of 10,000,000 crowns will be assigned for the beginning of the construction work in the budget year 1952-1953.

The international shortage of sulphur and iron-pyrites is likely to affect Swedish supplies, and it is therefore essential to start work on the Rudtjebaeck mine to increase output as soon as possible.

AUSTRIA

Aluminium smelter

A new smelting installation has gone into operation at the Austrian aluminium works in Lend, Salzburg, which produce about 6,000 tons of virgin aluminium annually. As the plant has its own power supply, it is not affected by the reduction in power supplies to large consumers—in contrast to the aluminium plant in Ranshofen, which is Austria's most modern aluminium works.

New chemicals produced

The Bleiberger-Bergwerks-Union of Carinthia have begun producing zinc sulphate and chloride, barium sulphate and chloride, and blanc-fixe. As Austria was hitherto mainly dependent on imports for supplies of these materials, a considerable easing of the supply situation is expected.

The expansion of the Austrian plastics industry, with the help of E.R.P. funds, continues. The Oesterreichischen Kunststoffwerke, Wels, are planning to produce polyvinyl chloride. This material is being made by the Solvay Werken of Hallein, in co-operation with I.C.I.

The Benzylzellulosechemie GmbH. of Hallein has begun producing benzylcellulose and claims to be the only firm in the world to manufacture this plastic material, which can be used both for injection and compression moulding. It is useful as a varnish base and for the manufacture of protective coatings.

The Vereinigten Chemischen Fabriken Kreidl, Rutter GmbH., have increased output of urea-based moulding materials, glues and varnish resins, and are considering the construction of a polystyrene plant.

SWITZERLAND

Record chemical exports

Exports from Switzerland increased in value by 14% during the first nine months of last year compared with the same period during the previous year. Exports of chemicals and pharmaceuticals amounted to 572,000,000 Swiss francs, 188,000,000 francs more than the previous year. Exports of machinery and plant reached the record figure of 705,000,000 francs while other export values included instruments and laboratory equipment, 217,000,000 francs, and aluminium, 43,000,000 francs.

PORTUGAL

New pulp and paper mill

The Portuguese Government has amended a licence granted to the Companhia Portuguesa de Celulosa Lda. for the erection of a large pulp and paper mill in Portugal. There are several conditions as to the stockholders and type and output of the products.

The company has received large sums under the E.C.A. aid programme and equipment purchased in the U.S., mainly pulp-making machinery, has arrived in Portugal. A large paper-making machine has been ordered from the U.K. Installations at the new mill are scheduled for completion by December 31, 1952.

ITALY

New PVC resins plant

Integrated facilities for the production of polyvinyl chloride resins and compounds of the Ultron 300 type manufactured by Monsanto in the U.S.A. are under construction at Porto Marghera, Italy, by Societa Industria Chimica, an Italian company in which Monsanto holds an interest.

A chlorine-caustic plant employing De Nora mercury cells has already been put into operation. Acetylene for producing vinyl chloride monomer will be made from calcium carbide from a nearby plant in which Societa Edison, major power company of Italy, has an interest. Societa Industria Chimica is a subsidiary of Edison.

The polymerisation plant, also being built at Porta Marghera, will be the largest of its kind in Italy.

FRANCE

Cement chemicals plant

An American company, the Concrete Chemicals Co., have decided to devote $90,000 under the E.C.A. scheme to the construction of a plant in France for the production of chemicals used in cement, for example, products included in new cement to give it the same properties as aged cement. Initially output will be at the rate of 180 tons p.a. and the products will be exported.

Polystyrene to be made

A 5,000-ton p.a. polystyrene factory is expected to be constructed during the course of the year by the Pechiney Co. Polystyrene has been produced by this company on pilot plant scale for the past few months.

GERMANY

New methods of producing Buna

The Hüls chemical works have resumed production of Buna from butadiene. Initial production is 500 tons of butadiene a month, of which 400 tons are being used for the production of Buna. The remaining 100 tons are being sent to the Bayer chemical works at Leverkusen for the manufacture of oil-resisting Perbunan.

The management hopes to increase production to almost 2,000 tons of butadiene per month next year and to export some of it. Present production of butadiene amounts to about 10% of total W. German rubber consumption of about 60,000 to 80,000 tons a year.

The management said the present production method on the basis of acetylene was already outdated, and it was intended to introduce a new method using a crude oil base to produce Buna. This might result in a lower price for Buna than the prevailing level of DM 4.66 per kg.

New chemical plant company

A new company, Deutsche Foster Wheeler GmbH, was recently registered in Germany with a capital of DM 20,000. The company will provide engineering services for German and foreign undertakings, and manufacture and promote the import and export of industrial equipment.

HOLLAND

Refinery catalysts plant

The first Continental factory to produce catalysts for oil refinery cracking plants is to be built by the Koninklijke Zwavelzuurfabrieken at Amsterdam. The factory is expected to start production in about 18 months' time and will have an annual output of 5,000 to 6,000 tons which, if necessary will later be increased to 10,000 tons. About 90% of the output will be exported. The company has already concluded contracts for the whole production of the first ten years with the Royal Dutch and Standard Oil companies for their refineries in France, Belgium and Germany now under construction.

Dutch refineries have hitherto had to import catalysts from America so that the new factory's output will save Holland an estimated 70,000,000 to 100,000,000 guilders in foreign exchange in the first ten years of its operation. Through its foreign contracts the factory will also earn foreign exchange. The plant will cost about 7,500,000 guilders. It is proposed to find this sum by the issue of 3,500,000 guilders' worth of new stock, and by borrowing privately 4,000,000 guilders.

NORWAY

Herring oil processing

A $1,000,000 plant to decolorise and fractionate herring oil into edible as well as industrial products is to be erected at Fredrikstad on the south-east coast of Norway for the De Nordiske Fabriker. The plant, to be supplied by the M. W. Kellogg Co., U.S.A., will operate by the *Solexol* process, which uses liquid propane for the selective separation of various constituents of oleagenous materials. This process has already been employed in the soap and food processing industries, notable applications being the fractionation of vegetable and animal oils and the production of vitamin concentrates from fish liver oils. Since *Solexol* is a low-temperature operation and also is claimed to assure close fractionation, it precludes damage to products from overheating and also provides for high purity of the individual fractions.

Several such plants, designed and built by Kellogg, are in operation in the U.S. and one in S. Africa. This is the first time, however, that any firm has adopted the process as a primary step in the production of edible products from fish oil.

The Fredrikstad herring oil plant will sell the edible products to margarine and shortening manufacturers. Other products, having drying characteristics, will be sold to manufacturers of paints, varnishes, etc. Capacity will be approximately 160,000 lb./day.

Saltpetre plant enlarged

Planned extensions at the Glomfjord saltpetre factory are expected to be completed soon, but delay in the supply of materials will mean that the new plant is unlikely to be ready for operation before the spring. When the work is finished, the production of ammonia will be increased by 150 to 200 tons/day.

SPAIN

Titanium dioxide output increased

The titanium dioxide production capacity of the Union Quimica del Norte de Espana has recently been increased. This company, which is one of the largest producers of mineral pigments in Spain, is also planning to increase production of synthetic methanol from 6 to 20 tons p.a.

FINLAND

New paper mill

The Finnish Enso-Gutzeit Co. has decided to build new pulp and paper mills in Tainionkoski with an annual capacity of about 100,000 tons. To ensure adequate power supplies, the company will build a hydro-electric power station of about 50,000-kW. capacity.

It is understood that Enso-Gutzeit has ordered a new paper-making machine from the U.S. which will be the biggest of its kind in Europe. This purchase has been made possible through the dollar loan granted by the International Bank for the development of Finland's wood products industries. Work on the new mill will start this spring.

KENYA

Pyrethrum processing plant planned

The East African pyrethrum industry is investigating the possibility of establishing an extraction plant at Nakaru to process a substantial part of the annual crop. Such a plant would be a co-operative enterprise of the growers and would be administered under the framework of the Kenya Pyrethrum Board. For this reason, as well as other market considerations, the board has refrained from forward selling of more than 50% of the estimated 1952 production.

SIERRA LEONE

Palm oil developments

A grant towards the cost of palm oil research work in the Protectorate has been made by the Sierra Leone Produce Marketing Board, who now have two Pioneer oils mills in operation. Four more are scheduled to be working soon and a further six by the end of 1952.

Iron ore exploited

Iron ore exports from the Marampa districts are now at the rate of 1,000,000 tons p.a. Operations are to be extended to the Tonkolili area, where preparatory work has already been carried out. Shipments of chrome ore are also increasing.

SOUTHERN RHODESIA

Oil-from-coal plans

Private companies have been invited to proceed with an oil-from-coal project at Wankie. The final report on the project, giving specifications and estimates of constructional and production costs down to points of distribution, is in the hands of the Government and is said to show that the production of oil from Wankie coal is a practical proposition.

NEWFOUNDLAND

Asbestos discovery

High-grade asbestos, worth about $1,500 a ton, has been exposed for a distance of 100 ft. in a drift now being made on property owned by Newfoundland Asbestos Ltd. at Lewis Brook, 10 miles from Fox

Island River, on the west coast of Newfoundland. The zone extends for a width of more than 15 ft. and the company intends to trench about 400 ft. along the zone. Asbestos occurs in veins of over 1 in. wide. The mouth of the drift is on the side of a steep cliff on the Serpentine River. A Government geologist was very much impressed with the prospects for the asbestos project.

INDIA

Engineers' register

A national register of scientific and technical personnel available in India is being compiled and the number of engineers who have voluntarily registered so far is 6,843 in the senior category and 4,309 in the juniors. These figures include 261 senior and 54 junior chemical engineers as well as 124 senior mining engineers.

Scientific institutions

Details of 59 scientific organisations are given in 'Scientific Institutions and Societies in India' recently compiled by the Indian Bureau of Education in co-operation with the National Institute of Sciences.

Calcium carbonate plant required

The U.K. Trade Commissioner at Calcutta reports that Khaitan Sons & Co., of 2 Dalhousie Square (East), Calcutta, are seeking quotations from U.K. manufacturers for the supply of two plants, one capable of manufacturing 10 tons of activated calcium carbonate and the other for producing 10 tons of activated magnesium carbonate, per 8-hr. day.

Khaitan Sons & Co. first intend to produce activated calcium carbonate; only when this is being produced satisfactorily will plant for manufacturing the other chemical be considered.

Interested U.K. firms are invited to send full details of their equipment direct to Khaitan Sons & Co.

BRAZIL

First oil pipeline

Part of Brazil's first oil pipeline has been put into operation, according to the contractors, Companhia Tecnica Internacional. This section is designed to carry light petroleum derivatives such as petrol, kerosine and diesel oil through a 10-in. pipeline.

The completed system will have two 10-in. lines, one 18-in. and one 22-in. in the section of the line between Alamoa and Cubatao, one 10-in. and one 18-in. between Cubatao and Utinga, Sao Paulo, and two distribution lines (6 in. and 14-in.) between Utinga and the distribution companies. There will be three pumping stations and one terminal (at Utinga). The storage system comprises 28 tanks.

All machinery and materials for the project were purchased in the U.S., except some of the 18-in. and 14-in. lines, which were bought in Germany.

U.S.A.

Another toxaphene plant

Plans for the construction of a $2,500,000 factory for the production of *Toxaphene* agricultural insecticides, have been announced by The Hercules Powder Co. The plant, to be located at Henderson, near Las Vegas, Nevada, is scheduled to be erected in 1953 and, when in operation, will increase the present U.S. output of *Toxaphene* by 25%.

New powder lubricant

A new powder lubricant, called *Grafize*, has been produced for industrial and workshop use by Betterby Inc., New York. According to the company, the lubricant works like graphite but eliminates the black smears associated with graphite. It is not an oil and will not melt, freeze or soil. Applied with a refillable rubber injector, it can either be blown dry into any moving part or mixed with lubricating oils and greases.

Magnesium production increased

An increase of 125% in U.S. production of primary magnesium this year to 220,000,000 lb. from 97,000,000 lb. in 1951, was forecast by Mr. P. D. Helser, chief of the magnesium branch of the U.S. National Production Authority at a meeting of the U.S. Magnesium Association. The increased output will be provided by seven Government-owned plants, now being re-activated. Their combined annual rated capacity is 196,000,000 lb. In addition, the Dow Chemical Co.'s plant at Freeport, Texas, has an annual capacity of 48,000,000 lb.

The primary purpose in re-activating the plants is to produce metal for the defence stockpile, but the higher needs of the defence industry has forced the General Services Administration to authorise also the distribution of some magnesium from these plants for defence orders. However, none of the Government metal would be used for civilian purposes. As production costs at the Government-owned plants might be higher than those of the only civilian producer, the Government was paying the difference in order to maintain the selling price, he added.

New titanium extraction process

A new process, said to make possible the continuous production of pure titanium in large quantities, is reported to have been developed at the Columbia University School of Engineering. While details of the process have not yet been released, it is stated to involve the electrolytic reduction of the chloride extracted from the original oxide compound. So far, it is not clear whether the titanium produced by the new process is of a grade suitable for industrial use and whether it will prove economical in commercial operations. Pilot-plant operation may be started in the near future to answer these questions.

Hitherto, the main problem encountered in extracting titanium metal from its ores has been its tendency to react and unite with such gases as oxygen, hydrogen and nitrogen. This has necessitated production on an individual batch basis, in the presence of an inert gas, usually argon.

Fivefold increase in synthetic fibre production foreseen

An increase in U.S. production of synthetic fibres by some 600,000,000 lb. annually within the next ten years was recently predicted in a report to the Southern Association of Science and Industry by Dr. J. Soday, Research Director, Chemstrand Corporation. Most of this increased production would be from plants located in the Southern States, which offered good factory sites and an adequate supply of labour, raw materials, fuel, power and water.

In 1950, U.S. production of synthetic fibres amounted to 145,000,000 lb. Output was expected to reach 400,000,000 lb. in 1953, 500,000,000 in 1958, and 750,000,000 in 1960.

Fertiliser consumption increases

Consumption of fertiliser in the calendar year 1950 reached an all-time record of 18,300,000 tons, according to Mr. J. E. Totman, chairman of the National Fertiliser Association, speaking at their Southern Convention. He said: 'Estimates indicate that consumption for the fiscal year ending June 30, 1951, was probably 19,000,000 tons. It appears that for the 1951-52 fiscal year there should be materials available to manufacture about 19,500,000 tons of fertiliser.'

Mr. Totman added that this certainly would not meet the demand; and by no means the tonnage that could be profitably used or that was necessary to produce needed crops, and, in addition, adequately maintain the fertility of the soil. He pointed out that solid forms of nitrogen would be scarce and the increase would be in the liquid forms. He said the fertiliser industry was particularly unfortunate in that two of its major raw materials—nitrogen and sulphuric acid—were also prime necessities in the manufacture of munitions. He termed the present position of potash 'satisfactory.' The phosphoric acid supply outlook, however, was not bright.

Sewage aids alcohol fermentation

There are indications that a new vitamin-like material found in by-products of sewage purification systems permits the production of more alcohol from sugar, according to Dr. B. Wolnak, Carl Miner Laboratories, Chicago. The new material, called the fermentation factor, was obtained from dried activated sludge which had previously been used only as a fertiliser.

Dr. Wolnak has found that additions of very small amounts of the powdered material to a fermentation where yeasts are

NEW DETERGENT PLANT AT PETIT-COURONNE, FRANCE

Claimed to be the most modern of its kind in Europe, this plant for the manufacture of 'Teepol' is now operating at Petit-Couronne (near Rouen), France. Its designed capacity is 25,000 tons p.a. Adjoining the existing Shell refinery, the new plant represents the first fruits of an association between Shell and the notable French chemical group Saint-Gobain. A combined manufacturing company, named Société Shell Saint-Gobain, has been set up in the joint interest. Several years' experience in operating the similar British and Dutch 'Teepol' plants—at Stanlow (Cheshire) and Pernis (near Rotterdam) respectively—has been incorporated at Petit-Couronne, and the special feedstock (a cracked petroleum wax) is derived from Shell refineries. An outstanding feature of the new plant is the high degree of automatic operation, which enables a staff of only 70 to run a highly technical installation.

converting sugar to ethyl alcohol causes the yeasts to work faster. The time was materially reduced, and this was true whether the sugar was derived from maize, cane or beet, or whether it was pure or impure, as in molasses or converted maize.

The activated sludge process was one which was used in the purification of domestic and industrial sewage, and involved use of the sewage in a vigorous fermentation. The laboratory evidence indicated that the fermentation factor was not any of the known vitamins or factors which had been identified to date. It appeared to be something new.

COLOMBIA

New alkali plant

A $15,000,000 alkali plant is scheduled to start operation this month, according to H. K. Ferguson Co., U.S.A., designers and builders of the plant, which is located near Bogota. Built for the Institute de Fermento Industrial, this is the first major unit of its type ever to be constructed in S. America. Preliminary and test operations in various portions of the works were carried out during the past few months.

The plant will have an annual capacity of 36,500 metric tons of soda ash, from which 18,250 tons of dense ash, 9,125 tons of chemical caustic, 5,380 tons of bicarbonate of soda and 3,600 tons of light soda ash could be produced. A refined salt plant with a capacity of 73,000 tons annually has been designed but not yet built.

The alkali products would be used by the textile, soap, glass, rubber, tanning and petroleum refining industries in the Bogota area.

CANADA

Phenol plant to be built

A 13,000,000-lb. p.a. phenol plant is to be built at Montreal for B. A. Shawinigan Co. (see INTERNATIONAL CHEMICAL ENGINEERING, August 1951, p. 394). Chief contractors are the Canadian Kellogg Co. Ltd. The plant will be the first commercial unit of its type and will operate by a process under licence from the Hercules Powder Co., U.S.A., and Distillers Ltd., London, by which cumene, a petroleum derivative, is oxidised to produce both phenol and acetone. Cumene will be piped from the Montreal refinery of British American Oil Co.

The phenol and acetone from this plant will be available for Canadian industry and export.

Sulphur recovery plant

A sulphur recovery plant is to be erected in Turner Valley, about 30 miles southwest of Calgary, for the Royalite Oil Co. Ltd., according to a statement by Mr. C. U. Daniels, president of the company. The site of this $350,000 plant, to be supplied by Foster-Wheeler Ltd., is adjacent to the present gas plant facilities.

The plant is expected to be in operation in April 1952 and will recover elemental sulphur from the hydrogen sulphide removed from Turner Valley natural gas and at present vented into the atmosphere. Capacity of the plant will be about 30 tons/day. During the first year of operation it is expected that production will be about 9,300 tons of sulphur.

CHILE

First oil refinery

Construction of a $10,000,000 refinery at a site 10 miles north of Valparaiso for Empresa Nacional Del Petroleo will begin in about a year's time, according to the contractors, the M. W. Kellogg Co., U.S.A. The refinery, a complete 20,000 barrel/day plant, will employ the most modern type of combination thermal processing equipment to produce several petroleum products from either indigenous or imported crude oils. With the exception of special facilities for the preparation of liquefied petroleum gases, the plant is similar, although larger in capacity, to one recently completed by Kellogg in Brazil. The firm is also currently building two additional plants in Brazil, one having the same capacity of the completed unit and the other having a capacity approximately one-half of the Chilean unit.

Products from the Valparaiso plant will include, in addition to liquefied petroleum gases, motor spirit, tractor fuel, kerosine, two grades of diesel oil and heavy fuel oil. They will be moved to marketing points by both pipeline and truck. Process facilities in the combination unit comprise crude oil distillation, vis-breaking, thermal reforming, thermal cracking, petrol stabilisation and treating equipment for sulphur removal from fuel gas, liquefied petroleum gases and petrol.

Organic intermediates

A useful reference work for chemists who have to deal with the laboratory synthesis of organic compounds has been published. This book* gives specific directions for the preparation of more than 500 organic compounds and it is claimed that none of the compounds are duplicated in the companion series, *Organic Syntheses*, although it contains the same type of information. Apart from the condition that it should not be described in *Organic Syntheses*, to be included in this book every compound had to be either not available commercially or relatively expensive. Other criteria of selection were that its structure should be simple and contain reactive functional groups that make it useful as an intermediate or that its preparation involved a generally useful type of organic reaction. The directions may also be applied to preparing related compounds. This book will be of value to every organic chemist interested in unusual chemicals.

**Preparations of Organic Intermediates*, by D. A. Shirley. Chapman & Hall, London, 1951. Pp. 328, including index, 48s. net.

MEETINGS

Institution of Chemical Engineers

January 8. 'Froth Flotation Kinetics,' by W. Gibb, 5.30 p.m., Geological Society, Burlington House, Piccadilly, London, W.1.

January 18. Graduates' and Students' Section. 'Management,' by D. I. W. Atkinson, 6.30 p.m., Caxton Hall, Westminster, London, S.W.1.

January 26. 'Preliminary Study of the Motion of Solid Particles in a Hydraulic Cyclone,' by D. F. Kelsall, 3 p.m., The University, Edmund Street, Birmingham.

Society of Chemical Industry

January 15. Chemical Engineering Group. 'The Patent Act of 1949,' by Norman Brown, 5.30 p.m., Burlington House, Piccadilly, London, W.1.

January 17. Road and Building Materials Group. 'Modern Quarrying Practice and some Problems connected with Crushing, Cutting and Polishing Granite,' by G. H. Hodgson, Penmaenmawr and Welsh Granite Co., Ltd., 6 p.m., Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1.

January 18. Fine Chemicals Group. 'Fine Chemicals and the Petroleum Industry,' by Dr. G. H. Visser, Royal Dutch Shell Laboratories, 7 p.m., King's College, Strand, London, W.C.2.

February 4. 'Man-made Fibres,' by W. A. Dickie, 6.30 p.m., Chemical Society, Burlington House, Piccadilly, London, W.1.

Institution of Mechanical Engineers

January 11. 'Rubber Technique in Engineering,' by J. Kelly, 5.30 p.m., Storey's Gate, St. James's Park, London, S.W.1.

Royal Institute of Chemistry

January 24. 'Luminescence in Inorganic Chemistry,' by C. G. S. Hill, 7.30 p.m., Acton Technical College, High Street, London, W.3.

January 24. 'Fundamental Problems in Accumulator Manufacture,' by Dr. M. Barak, Chloride Electrical Storage Ltd., 6.45 p.m., Reynolds Hall, College of Technology, Manchester.

January 31. 'Separation of Gases by Low Temperature Methods,' by Dr. J. B. Gardner, 7 p.m., Battersea Polytechnic, London, S.W.11.

Chemical Society

January 18. 'Contributions of Wave Mechanics to Chemistry,' by Prof. C. A. Coulson, 7.15 p.m., The University, Glasgow.

January 21. 'Recent Developments in Acetylene Chemistry,' by Prof. E. R. H. Jones, 6.30 p.m., The University, Leeds.

January 22. 'Inorganic Chromatography,' by Dr. F. H. Pollard, 5 p.m., Washington Singer Laboratories, Prince of Wales Road, Exeter. Joint meeting with the R.I.C. and S.C.I.

January 25. 'Contributions of Wave Mechanics to Chemistry,' by Prof. C. A. Coulson, 5.30 p.m., King's College, Newcastle-upon-Tyne.

January 29. 'The New Elements,' by Dr. F. Fairbrother, 6.30 p.m., The University, Leeds.

January 31. 'The Place of Trans-uranium Elements in the Periodic Table,' by Dr. J. S. Anderson, 4.45 p.m., The University, Nottingham.

January 31. 'Physics and Chemistry of Monolayers,' by J. H. Schulmann, 6 p.m., University College, Hull.

Fertiliser Society

January 10. 'Recent Advances in NPK Chemical Analysis,' by Dr. J. H. Hamence and R. Donald, 2.30 p.m., Tudor Room, Caxton Hall, Caxton Street, London, S.W.1.

Institute of Fuel

January 14. 'Modern Boiler Plant,' by A. S. Dodds, 6.30 p.m., King's College, Newcastle-upon-Tyne.

January 15. 'Llandarcy and Fuel Efficiency,' by R. B. Southall, 5.30 p.m., Institution of Mechanical Engineers Storey's Gate, St. James's Park, London, S.W.1.

January 15. 'Recent Developments in Coal Carbonisation,' by Dr. W. Idris Jones, 6 p.m., James Watt Institute, Great Charles Street, Birmingham, 3.

January 16. 'Boilers,' by H. E. Partridge, 6.30 p.m., Engineers' Club, Albert Square, Manchester.

Institute of Metal Finishing

January 21. 'Non-Electrolytic Smoothing Treatment for Steel,' by W. A. Marshall, Northampton Polytechnic, St. John Street, Clerkenwell, London, E.C.1.

January 25. 'Tin-Zinc Deposition,' by J. S. Bowden, Grand Hotel, Sheffield.

February 5. 'Plating Plastics,' by D. McPherson, James Watt Memorial Institute, Great Charles Street, Birmingham, 3.

Institute of Metals

January 15. 'Metallurgy and Transport,' by T. Henry Turner, 6.30 p.m., Metallury Department, University College, Singleton Park, Swansea.

January 15. 'Corrosion of Metals,' by U. R. Evans, 7 p.m., Oxford.

February 5. 'Non-Destructive Testing of Metals,' by C. Croxson, Oxford.

Liverpool Metallurgical Society

January 11. 'Use of Radioactive Tracers in Metallurgical Research,' by Dr. H. M. Finniston, 7 p.m., Electricity Service Centre, Whitechapel, Liverpool.

Liverpool Engineering Society

January 7. 'Modern Developments in Electric Welding,' by Dr. H. G. Taylor, 6.30 p.m., Royal Institution, Colquitt Street, Liverpool. Joint meeting with the Institution of Electrical Engineers.

Manchester Association of Engineers

January 25. 'Dust Precipitation,' by G. C. Goodwin, 6.45 p.m., Engineers' Club, Albert Square, Manchester.

Manchester Literary and Philosophical Society

January 23. Chemical Section. 'Impressions of American Technical Education,' by Dr. P. F. R. Venables, 5.45 p.m., Portico Library, Mosley Street, Manchester.

Institute of Petroleum

January 15. 'Technology and the Salesman,' by V. M. Farrant, 6.30 p.m., Engineers' Club, Albert Square, Manchester.

Hull Chemical and Engineering Society

January 29. 'Screening and Cleaning of Coal,' by C. Spiller, 7 p.m., Church Institute, Hull.

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